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**ZOOLOGICAL RESEARCHES,**  
**AND ILLUSTRATIONS;**

OR,

**NATURAL HISTORY**

OF

**NONDESCRIPT OR IMPERFECTLY KNOWN ANIMALS,**

IN A SERIES OF MEMOIRS.

*Illustrated by numerous Figures.*

---

**BY JOHN V. THOMPSON, ESQ. F. L. S.**

DEPUTY INSPECTOR GENERAL OF HOSPITALS.

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“ ——— for Thy glory all these beauties rise,  
Yet may improve the good, instruct the wise.”

SOMERVILLE.

**VOL. I. PART I.**

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TO  
SIR JAMES M'GRIGOR, M.D. F.R.S. K.C.T.S.  
DIRECTOR GENERAL  
OF THE  
ARMY MEDICAL DEPARTMENT.  
AS THE FRIEND OF EVERY PURSUIT  
WHICH CAN CONTRIBUTE IN THE MOST REMOTE DEGREE  
TO THE INCREASE OF NATURAL KNOWLEDGE,  
AND PARTICULARLY TO THE PERFECTION OF MEDICAL SCIENCE,  
BY EXTENDING OUR VIEWS OF  
THE PRINCIPLE OF LIFE, AND OF THE VARIOUS FUNCTIONS AND  
HABITUDES OF ORGANIZED BODIES,  
AS INFLUENCED BY DIFFERENCE OF ANATOMICAL STRUCTURE,  
THIS WORK  
IS INSCRIBED  
BY HIS VERY FAITHFUL SERVANT,  
THE AUTHOR.





## ZOOLOGICAL RESEARCHES.

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### MEMOIR 1.

*On the Metamorphoses of the Crustacea, and on Zoea, exposing their singular structure and demonstrating that they are not, as has been supposed, a peculiar Genus, but the Larva of Crustacea!!*

THE transformations which animals undergo in their progress from the egg to a perfect state, have ever been regarded as among the more remarkable traits which their history affords; these, as they affect the *Land* animals offer themselves freely to our observation, and have been ascertained to be strictly confined to the class of true insects: the marine and aquatic animals in general (exclusive of amphibious insects) never emerging from an element which presents numerous obstacles to the investigation of their habitudes, have been considered as undergoing no metamorphosis, with the exception of a few aquatic Reptiles, and some genera of the Linnean Monoculi, viz. *Apus*, *Branchipus*, *Cyclops* and *Argulus*; indeed so decided has been this notion in respect to the more perfect Crustacea, (*Malacostraca*) that the acute and indefatigable Doctor Leach, one of the chief investigators of this tribe of animals, has assigned it as one of their principal characters, *that they undergo no metamorphosis*. ENCY. BRIT.—Art. Crustacea.

One of the objects therefore of the present Memoir, will be to show the erroneous nature of this opinion, and to announce the *important discovery*, that the greater number of the Crustacea do actually undergo transformations, of which, in addition to the facts now adduced, further instances will be given in future memoirs.

The circumstance of the Crustacea being supposed to pass through no intermediate form, has been brought forward heretofore as one of the arguments for their separation from Insects; but, although the fallacy of that opinion may diminish the number of the characteristics which distinguish these two tribes of animals as *distinct Classes*, there yet remains those depending on the anatomical structure of their respiratory and circulating systems, which are quite sufficient to render the separation permanent. It may also be observed, that the changes presented to our notice in the Crustacea are quite peculiar, and of a totally different description from those of Insects.

The sea (which is the habitation of the greater part of the Crustacea,) to the casual observer, offers nothing but an immense body of water, here and there presenting a solitary whale, or a vagrant troop of some of the smaller Cetaceous animals; the appearance of a fish of almost any other kind in the track of a vessel over the vast expanse of the open ocean, is regarded even by the mariner, as a kind of phenomenon, and creates an interest not to be appreciated by those who have not engaged in distant voyages. The fathomless parts of the ocean certainly do not offer the same profusion of inhabitants with the shores of Islands and Continents, or those parts where the bottom is within the reach of the sounding line, or where its surface is interspersed with fields of Sargosa (*Fucus natans*;) on due examination however, we shall not fail to find it every where peopled by a considerable variety of animals either of small size, or possessed of such a degree of translucency as to render them invisible, or scarcely



perceptible even when on, or near to, its surface : that it should possess its share of the organized beings which we see spread over every other part of the surface of our globe, is a conclusion we might arrive at indirectly, from the consideration of Oceanic fishes and birds being observed in those parts of the ocean most distant from the land, and the provident care of the Deity which we invariably witness throughout the domain of nature, to furnish food for all the meanest of his creatures ; the more minute and invisible inmates of the sea then, must constitute the food of Oceanic fishes and birds. Few of these marine animals, except some of the larger and more conspicuous, have as yet been observed, so that the investigation of them holds out the promise of a rich harvest to the Naturalist and a vast field of exploration replete with novelty and interest ; \* to accomplish this object however, he must use the greatest diligence, seizing every opportunity when the way of the ship does not exceed three or four miles per hour, to throw out a-stern a small towing net of gauze, bunting, or other tolerably close material, occasionally drawing it up, and turning it inside out into a glass vessel of sea water, to ascertain what captures have been made ; when a ship goes at a greater rate, and in stormy weather, a net of this kind might be appended to the spout of one of the *sea-water* pumps, and examined three or four times a day, or oftener, according to circumstances.

The luminosity or sparkling of the sea by night, is a phenomenon which never fails to attract the attention of voyagers the most incurious, and having been found in the greater number of instances, to be produced by marine animals, first led the author into the use of the towing net, and discovered to him the variety and profusion in which they occur, both luminous and otherwise, and amongst others, the animals which form the subject of the present memoir.

\* To speak the truth, our own seas have been almost as little explored, although they teem with curious and unknown animals.

The animals of the supposed Genus *Zoea*, have been hitherto little known from their small size, transparency, and the other circumstances above alluded to. Slabber, Bosc and Cranch, are the only Naturalists who have had the good fortune to observe them ; to these may be added the author, who in towing for luminous animals, during a voyage from the Mauritius in 1816, discovered the species figured in Plate I. fig. 2, and fig. 4, *a. b.* without having it in his power to throw any new light upon their nature or structure : great variety of subjects, and the difficulty of pursuing microscopical dissections of minute animals on so turbulent an element, having prevented this being followed up at the moment, and having subsequently lost these specimens, we might have remained for an indefinite period without the knowledge of their *real* nature, the profusion in which they occur in our own seas, their variety, and the peculiarities of their structure, had not he continued to use the muslin towing net, for the detection of minute marine animals, since his return to Europe ; many, and important, have been the results of this simple procedure, but none attended with greater surprise, than the vast profusion of the animals of *Zoea* discovered on our coasts and in our bays and estuaries, the novel and curious history of which, it is intended to give in this and subsequent memoirs.

Slabber in a Dutch Work entitled “Natural Amusements and Microscopical Observations” published at Harlem in 1778, has given us a description and figure of the species which has been since designated *Zoea taurus*, Plate I. fig. 1, *a* (in outline and without adventitious groups of a vorticella) several of these were taken at sea, July 24, 1768. From the observers of that period, any very exact analysis of such an animal was not to be expected, its whole length being but  $1\frac{1}{2}$  line ; he describes it as of a greenish colour, the tail paler, the corselet with a long frontal and dorsal spine, the fourth joint of the tail with a projecting spine



behind, and the fifth or terminal joint formed as in all the genuine Zoeas, of a deep fork, the inner sides of which are furnished with three small spines, the feet he erroneously counted as eight, none of them provided with more than four terminal plumose setæ, the antennæ entirely escaped observation, nor does it appear whether there are any lateral spines to the corselet. Upon the whole, we ought to feel grateful to Slabber for the first and most characteristic figure that has been given of these curious animals, and the pains he took to throw light upon their history.

Bosc, one of the most judicious naturalists of the French school, in a voyage which he undertook to America with a view to Natural History, discovered a single individual of the species figured Plate I. fig. 3 in the Atlantic Ocean, 5 or 600 leagues from the coast of France; and justly conceiving it distinct from all the other Genera of the Crustacea, first instituted that of Zoea for the reception of these anomalous animals, distinguishing the above species by the title of *pelagica*; it appears to have been one of the smallest size, transparent as glass, and differs from the former, principally, by the addition of a long deflected lateral spine on each side of the corselet; the antennæ did not entirely escape the observation of this able and zealous Naturalist, but he also failed in detecting the peculiar structure of its other members.

Mr. Cranch, in the course of Captain Tuckey's Voyage to the Congo, discovered the curious and singular species Plate I. fig. 5. in N. Lat.  $1^{\circ} 56''$ , W. Long.  $8^{\circ} 46,37''$  which Dr. Leach has named *Z. Clavata*, from the club-like shape of its dorsal and lateral spines.

Of the two species observed by the author in 1816, that taken September 17, N. Lat.  $16^{\circ}$  W. Long.  $26^{\circ} 37''$  and figured Plate. I. fig. 2. resembles most the *Zoea taurus* of Slabber, its frontal and dorsal spine shorter in proportion; the lateral spines sufficiently conspicuous; the three anti-

penultimate joints of the tail with a short adpressed spine on each side; the other projections seen in the figure at the sides of the body and tail, are probably parts of the bent up members of the animal; it was quite transparent, and occasionally luminous and scintillating by night. The second species, taken August 22, in S. Lat.  $17^{\circ} 30''$ , W. Long.  $1^{\circ} 30''$  and figured Plate I. fig. 4. *a.* and *b.* was like the former discovered by its luminous scintillations in the dark, and when examined next day, it appeared to have no spines strictly to be called *lateral*, or *dorsal*; the anterior spine is short, as in the former, and posteriorly, the corselet ends apparently in three short spines; the tail being bent up close under the breast of the animal was not observed; the setæ which terminate the feet, were very long and feathered: this may probably be the second species of which Bosc appears to have had a glimpse, and which he describes as being black and without any dorsal spine.

Up to the year 1822, these were all the *Zoeas* known to Naturalists, who, while they agreed as to their being Crustacea, could not determine the place they ought to occupy in that Class. Slabber referred them to the Monoculi! although so obviously provided with a pair of extremely large and distant eyes: most of our contemporary Naturalists of the greatest discrimination, still associate them with the Entomostraca, an order formed out of the Linnæan Monoculi;\* others, not less puzzled by the association of characters belonging to widely separated groups, have preferred approximating them to the more perfect Crustacea, thus Bosc† places them at the head of the *edriophthalma* (onisci &c.) and considers them to be intermediate between these, and the *podophthalma* (lobsters,

\* Latreille, Hist. Nat. des Crust. &c. Sonnini's edit. of Buffon, 1802, and in his Genera Crust. et Insect. 1807. Dumeril, Zoologie analytique, 1806.

Cuvier, Regne Animal, 1817. Lamarck, Animaux sans Vertébrés, 1818.

† Hist. des Crust, Castel's edit. of Buffon.

&c.) Dr. Leach, with that uncommon foresight for which he is distinguished, placed them at the tail of his mala-costraca,\* until having inspected the species discovered by Cranch, he declared them to belong to the podophthalma, and to the same group with Nebalia.† It will no longer be a matter of surprise, that all the leading Naturalists of the present day, should have been at a loss how to dispose of Zoea in their arrangements of the Crustacea, when it is known, that this singular type, is not a perfect animal, but merely the *larva* or imperfect state of the *Crab*! and not as had been imagined, an animal *sui generis*! This is a discovery quite new, and interesting in a double point of view, as proving their real nature, and that the more perfect of the Crustacea undergo a Metamorphosis, and that of a description totally different from any hitherto known; so little has this been suspected by Naturalists, that as before stated, the contrary has been assigned as one of the distinctive characters of the class, and been used as an argument for their separation from insects. It may be urged, that this is no new discovery, and that Slabber has the merit of having first indicated a metamorphosis in the Crustacea; the metamorphosis however, which this observer thought he witnessed, is of so different a description, that we must either suppose him to have fallen into some error, or that there may be Crustacea which pass through other forms than those now for the first time made known. That Naturalists may be put into possession of all the circumstances necessary to a just decision, we shall first point out the supposed discovery of Slabber, and then state what we have ourselves observed.

Slabber, wishing to continue his observations on his Zoea, took care to renew the water in which it had been placed, and on the third day, finding its movements become slower, and its colour more pale, he subjected it to the

\* Art. Annulosa, Suppl. Ency. Brit. † Captain Tuckey's Voyage to the Congo.



microscope, and found to his surprise, that the anterior portion of the animal had changed its form, and on the fourth day it had acquired the appearance represented Plate I. fig. 1, 6, so that together with the other individuals he had taken, it seemed to have experienced a complete metamorphosis; under this new form, the dorsal spine had disappeared, the front spine had become comparatively small, the antennæ were rendered conspicuous, the feet and eyes were apparently more developed, and the tail had changed from forked to spatulate, fringed by a row of thirteen short spines. It will readily occur to the reader, that observations made in this way, upon aquatic animals at once so minute and so transparent, require the greatest care and circumspection to insure any positive result; from much experience, the author is led to suppose, that Slabber lost his *Zoeas* in changing the sea water, and that the new form came from the added portion, a circumstance rendered more probable, by his having met with both these types at the same season of the year.

It was during the spring of 1822, that the author to his great surprise, first met with *Zoeas* in the harbour of Cove, and that in considerable abundance; the year following at the same season, one of considerable size occurred, amongst a great number of smaller ones, and judging it full grown, (Plate II. fig. 1, 2,) and a fit subject to keep for the purpose of witnessing the metamorphosis observed by Slabber, it was daily supplied with fresh sea water in the most careful manner, from May 14, until the 15th June, when it died in the act of changing its skin, and of passing into a new form, but one by no means similar to that expected, as appears evidently by its disengaged members (fig. 11.) which are changed in number, as well as in form, and now, correspond with those of the Decapoda, (Crabs, &c.) viz. five pair, the anterior of them furnished with a large claw or pincer: the metamorphosis not having been completed, prevented any knowledge

being acquired of its general form, enough however has been gained to shew, that the distinctive characters of Zœca, and of Slabbers changed Zœca, were entirely lost, that the members, from being natatory and cleft (as shall shortly be shown,) become simple, and adapted to crawling only. On the 1st of May of the present year, (1827,) another large Zœca was taken, and dying towards the end of the month without having the requisite strength to disengage itself from the exuvium, presented precisely the same results with the former.

The proof however might be deemed incomplete, had not the author the good fortune to succeed in hatching the ova of the common Crab (*Cancer pagurus*) during the month of June last, which presented exactly the appearance of Zœca taurus, with the addition of lateral spines to the corselet: the *Crustacea Decapoda* then, indisputably undergo a *metamorphosis*, a fact, which will form an epoch in the history of this generally neglected tribe, and tend to create an interest which may operate favorably in directing more of the attention of Naturalists towards them. In their first and tender stage, they are essentially and purely *natatory* animals, and no doubt possessed of corresponding habits, swimming about freely and without intermission in search of appropriate food; in their perfect state, the greater number can no longer avail themselves of the power of swimming, but are furnished with pincers and feet almost solely adapted to crawling, so that they are now under the necessity of confining their excursions in pursuit of prey within more narrow limits. This curious piece of economy, explains what has ever appeared paradoxical to naturalists, viz. the annual peregrinations of the Land-Crabs to the sea side, which, although acknowledged to be true by several competent observers, could never before be satisfactorily accounted for.

Having avoided going much into detail of the structure of the Zœcas so imperfectly observed by the authors cited,

it only remains to unfold this part of our subject, in order to render their history complete, premising, that the following description has been derived from one of the full grown specimens above alluded to, which may therefore be supposed to differ from such as occur of smaller size in the greater degree of developement of all its parts; thus, the eyes are more distinctly pedunculate, the natatory division of the feet have an increased number of plumose setæ, the rudiments of the sub-abdominal fins are quite obvious, and the mandibles shew the rudiment of a palp; in other respects they are essentially the same.

The *Eyes* are large, distant from each other, and although on short footstalks, do not appear to be possessed of any obvious motion.

The *Corselet*, or cephalo-thoracic-clypeus covers the back and sides of the animal, and is prolonged in front into a long deflected spine, and has another long spinous projection on the posterior part of its dorsum, and a pair of short lateral spines.

The *Abdominal* portion uncovered by the clypeus, is composed of four semicylindric narrow joints, each furnished with the rudiment of a pair of sub-abdominal fins, and is terminated by a deeply forked tail, spinous within.

The *Antennæ* or feelers, are double on each side; the inner pair being short, and composed of two basil joints, surmounted by two lobes, of which one lobe is very short, and the other 3-articulate and setose; the outer pair consist of three parts, the central or principal one, large, long, and taper, the lateral ones small and short, one of them of 3 articuli, and attached to the base of the central division, the other also articulate, ending in two setæ, and originating from the first joint of the principal.

The *Members* or legs, consist of but *two* pair, each divided into an outer and inner limb, of which, the outer divisions are adapted to natation, and the inner to the



service of the mouth, the former projecting laterally, while the latter are carried in a forward direction, and nearly concealed beneath the body of the animal.

The apparatus of the *Mouth* consists of a pair of strongly toothed mandibles, furnished with the rudiment of a palp, and of two pair of jaws, (maxillæ) together with an upper and under lip: the maxillæ are lobed and spinous, with an external articulated appendage, the innermost of them furnished with a broad ciliated scale at its base, serving it is presumed to fan or aliment the respiratory organ; the labrum or upper lip, is semicircular and simple, the under lip bilobate and bearded.\*

Independent of the knowledge we *now* possess of these animals, we should from the foregoing detail, refer them without hesitation, as Dr. Leach has done, to the Shizopoda, or cleft-footed Malacostraca, and consequently next to Nebalia, which is also most probably a crustaceous animal in its progress to a more perfect state; in which case, the only true Shizopodæ as yet described, are the animals of the Genus Mysis or Opossum Shrimp, the structure and natural history of which, are detailed in the following Memoir.

\* The French have adopted the term *Zoe* for these animals, which, as more simple, and better suited to the genius of our own language than the Latin, may be used in familiar discourse without any impropriety.



## MEMOIR II.

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### *On the Genus Mysis, or Opossum Shrimp.*

THE Mysis, or Opossum Shrimp, a Genus instituted by Latreille, appears to have been hitherto noticed by very few Naturalists, and to the bulk of such even as devote themselves to Zoology alone, they may be said to be wholly unknown; those few who have had opportunities of observing them, although they have given us some imperfect notion of their structure, have left their singular economy a mere blank, from a practice hitherto much too prevalent, of attending almost solely to the more remarkable differences which distinguish one genus or species from another, as if this was the only object worthy our attention, whilst those circumstances of structure and economy which give a real interest to natural history are either neglected or overlooked. The object of this Memoir therefore, will be to make the Opossum Shrimps more generally and perfectly known, and to display the more remarkable traits in their economy, and may thence be considered as having novelty to recommend it to the attention of the curious; at the same time it may be observed, that the Marsupial Quadrupeds or Opossums, (although so long and so well known) having lost little of their original interest with the admirers of the works of creation, induces a hope, that a somewhat similar economy displayed for the first time in an animal of a very inferior order, may not be without its attractions; if in addition to these circumstances we take into account the *extraordinary peculiarities of structure*, which these animals present to



our notice, in being provided with a *quadruple* row of feet or members, and with hands vastly more complicated and beautiful than in man, or any known creature, there could hardly be found a subject more worthy to engage our contemplation, or more capable of inspiring us with adoration of the Divine Perfection, as manifested in the minuter works of creation.

It will hardly be credited that such interesting peculiarities could have remained unnoticed, when it is known, that the Opossum Shrimps are in these climates the most common of all the Crustacea, that they abound to such a degree, as to astonish by their countless myriads, and that (unlike all the other animals of their class) they offer themselves freely to our view when we stroll along the margin of our estuaries, where, particularly in spring and summer, they may be observed forming an almost continuous band or column of some feet in breadth, extending along either margin of the tide, from the sea up to where the water becomes almost fresh. If we stop to consider so singular a piece of negligence, it only furnishes a proof of the little attention that has hitherto been paid to this class of animals.

The Opossum Shrimps belong to a small group of the Crustacea, at present embracing but three or four Genera, which it is proposed to develope in succeeding Memoirs, as they are for the most part nondescript, and in other respects highly interesting; this group has been designated by modern systematists as a *family*, under the title of Shizopoda or Fissipedes, from the singular circumstance of having all their feet or members divided to their very origin into two parts or limbs, the inner limb being constructed for progression and the seizing of their prey, and the outer one for swimming and the giving that motion to the water which is essential to the respiratory organs; which organs, with a view to the due oxygenation of their circulating fluid, are as it were wrapped around the base

of this limb, and fully exposed to the action of the ambient fluid : in the other Crustacea to which they most nearly approach in appearance, as the Shrimps, Prawns, and Lobsters, it may be observed, that there is a single row of *five* feet on each side, (and they are hence designated by the family title of Decapoda) and these adapted to crawling, except some of the anterior pairs, which are generally chelate or formed into a kind of pincers ; and further, that the branchia or gills, which are attached to the outer part of their base, are reflected backwards and upwards, and entirely protected and concealed by the sides of the shell or cephalo-thoracic-clypeus.

The number of feet in this Genus, and in such of the Shizopoda as are thoroughly known, is *eight* in each of the *four rows*, in all thirty-two feet ! of which sixteen are adapted to prehension, and sixteen to swimming. We plainly perceive in this instance, how organization modifies the habits of these two descriptions of Crustacea, the Shizopoda being almost always found swimming near the surface of the water, whilst the Decapoda with extended tails, (Macroura) as the true Shrimps. &c. are obliged to confine their perambulations to the bottom ; these latter it is true are not altogether incapable of swimming, but when they do, it is evidently an effort, and effected solely by means of the subcaudal fins : it results from the above economy, that these, clear the bottom of numerous impurities, and by their predacious habits, keep in check the mollusca, annelides, &c. below, whilst those, (the Shizopoda) effect the same purpose in the supernatant element, where the medusæ and lighter portions of extraneous matter, furnish an equally abundant stock of nutriment ; thus the ocean is freed from much of its impurity, and the balance of nature sustained.

Confining our views to the Genus Mysis or Opossum Shrimp, it may be observed by reference to the magnified figure, Plate I. fig. 1. that its general appearance approx-

imates much to that of the Shrimps and Prawns, but independent of the number and structure of the feet and branchia above stated, the abdomen, which is always kept extended, is furnished with fins of a very peculiar structure, Plate I. fig. 9, added to which, the female is provided with a post-thoracic pouch, Plate I. fig. 1. *u.* composed of four concave valves, which are articulated inside the base of the two posterior pair of legs, and strongly ciliate or pectinate where they meet in front: of these valves the posterior are the most capacious, and exterior to the others; it is within this pouch, that the eggs are received when excluded from the ovarium, and enveloped in a mucous or subgelatinous secretion, and gradually developed without any visible attachment to the parent. The ova when first received into the pouch, are considerably more advanced than those of the Shrimps, Crabs, &c. on their first expulsion, and by no means so numerous, a circumstance more than compensated by the rapidity with which one brood succeeds to another during the whole of the spring and summer months: the number of broods produced by one individual, as well as the time occupied in their evolution, have not been determined, but the changes which the embryo undergoes in configuration are sufficiently obvious; in the present instance, these cannot be considered as metamorphoses, but simply a gradual development of parts, hence the Shizopoda may be regarded as one exception to the Crustacea undergoing transformations, another character by which they are separable from the true Shrimps, &c. to which they bear the same relation that the Syren among the reptiles (amphibia) does to the family of Lacerta. The first change which is perceptible in the ova after their reception into the maternal pouch, is a slight elongation at one end, and the appearance of two short members at each side, Plate I. fig. 10, *b*; this elongation which proves to be the tail, increasing in length, shortly after, becomes forked at the end, accompanied by



a proportional growth in the four lateral members fig. 10. *c.* and which are the rudiments of the two pair of antennæ in the perfect animal, the embryo going on thus with a progressional developement from day to day, begins to assume a more complete form, and 'an approximation to that of the parent, fig. 11, in which stage the divisions of the abdomen, the tail, the pedunculate eyes, and the various members are sufficiently distinct; a still more close resemblance to the perfect animal is attained before the young are finally excluded, which is effected by the parent spreading open the valves of its pouch, when the whole brood emerge at once into the ambient element, and in most of the species, continue associated with the community from which they sprang: the slight differences which they now present, (and which are necessary to be known in order to preclude the possibility of their being mistaken for individuals of a different species,) affect only the inner rows of feet, the sub-abdominal fins, the outer antennæ and the tail; the first of these, in place of the multi-articulate termination seen in Plate I. fig. 8. *a.* have but one or two short joints and a curved claw fig. 12, superadded to the end of the tibiæ, and hence this division of the limb is shorter in proportion; the sub-abdominal fins consist only of a linear joint surmounted by a few bristly hairs, and do not put on the elegant appearance seen in fig. 9; the outer antennæ differ in no other respect than in the ciliated scale which is attached to their base, being shorter and less developed, as is also the brush of hair in the males fig 5; the three intermediate scales of the tail are proportionably shorter, but yet present the character peculiar to the species, in their form, indentations, and appendages, so as to testify the acuteness of Dr. Leach in having fixed upon this part to distinguish the species from each other.

What is further remarkable of the embryo, is the way in which they are arranged within the pouch from the

moment they assume an elongated form; their heads being towards the breast of the mother, with the curvature of the tail part suited to that of the outline of the pouch, the convexity being at the same time invariably on the belly side, fig. 11, which is the more singular, since the curvature of the perfect animal, and of other embryo Crustacea is as invariably in a quite opposite direction; after this manner, they lie closely compacted together, and present a perfectly symmetrical arrangement, easily observed from the translucency of the valves of the pouch, and the large size and blackness of their eyes.

This curious and extraordinary piece of economy can hardly fail to be regarded by the Physiologist as equally interesting with that of the Opossums, and other Marsupial Quadrupeds, and of a much more unaccountable nature; for in these last, although the object of the Creator is not obvious, yet we can understand the manner in which it is carried into effect, the young being excluded from the uterus when they have scarcely attained a fourth part of the growth of the embryos of other animals—naked, helpless and blind, they are received into the abdominal pouch of the mother, and by some wonderful instinct, or by the mother's agency, attached each to one of the teats which are situated within it, from whence, when sufficiently grown, they make occasional sallies, until able entirely to provide for themselves; in the Opossum Shrimp on the contrary, we comprehend the object, but are completely at a loss to account for the manner in which it is brought about, for these animals have nothing analogous to teats, the embryos have no visible attachment to the mother, appear to be in no capacity to take food, nor to carry on the respiratory function. It is nevertheless probable, that the secretion in which they are immersed, constitutes the source of their nutrition, whether taken in by suction or by absorption; yet if we admit this, what are we to think of the function of respiration thought to be equally neces-

sary with nutrition to the continuance of life and the evolution of the fœtus, as the subgelatinous secretion appears to exclude the direct influence of the ocean upon the respiratory organ, which moreover does not appear to be developed until the moment prior to their exclusion from the pouch, this circumstance, taken in conjunction with the suspicions of some Physiologists as to the oxygenation of the fœtal blood, may lead to such further observations as may tend to throw some new light upon this still obscure function in the fœtus.

To the Philosophical Naturalist, who delights to trace the changes which parts are made to assume in figure and use, in contiguous groups of beings, so as to fit them for different modes of life, the Opossum Shrimp must prove highly interesting, for independent of the peculiar structure or modification of its feet before noticed, and which renders it essentially natatory, it points out to us in the clearest manner possible, by the changed appearance of its three anterior pairs\* of feet, that what have been considered in the Crabs and Lobsters, &c. (Decapoda) as three pair of auxiliary jaws or *Pedi-maxillæ*, are no other than the above members in a disguise which seems to appropriate them in a decided manner to the service of the mouth; for in the Decapoda there are (as the name of the family implies) but five pair of feet, and three pair of auxiliary jaws, which jaws being added to the front of the series of feet in the Opossum Shrimps, encreases their number to eight pairs, of which the sixth, reckoning upwards, are not to be distinguished in structure from those posterior to them.

The males in this Genus appear to be much less numerous than the females, and differ principally in being smaller, and in the substitution of a peculiar organ between the last pairs of feet (Plate I. fig. 13, 14.) instead

\* The peculiar structure of the limbs, being subdivided into two, renders necessary this unauthorized application of *pairs*.



of the valvular pouch of the other sex ; they have further the addition of an appendage at the bifurcation of the inner antennæ, so densely tufted as to resemble a brush, (Plate I. fig. 5 ; ) it is probably this appendage which has induced Naturalists erroneously to assign to *Mysis*, *trifid* interior antennæ.

Hitherto, the Opossum Shrimps have not been observed further South than the precincts of the English Channel, but they occur as far to the North as the icy seas of the Polar regions, where they must exist in very great abundance during the summer season, as they are said by O. Fabricius to constitute one of the principal sources of nutriment to the Whale, which taking in myriads at a gulp, separates them from the water by means of its complicated strainers, and swallows the congregated pabulum which they now form, at leisure ; we should hardly give credence to the fact, that an animal so disproportioned, should constitute the food of this Leviathan, did we not perceive that the peculiar structure of the mouth, and smallness of the gullet in these enormous creatures (the Mysticete Whales) is in perfect accordance, and fits them for separating small and soft animals of every kind from the sea water, while it precludes the power of masticating, or of swallowing bodies of even moderate size : abundance in this instance, makes up for the individual smallness of the prey, and these little animals must be allowed to be a much more substantial food than the medusæ, upon which the whales are also understood to feed. In these climates, the Opossum Shrimps serve as food to the herring and pilchard, and probably to many other fishes, and although by their numbers they might tempt the epicure to serve them up in the aggregate, as they do the young fry of fish in some parts of the world, the species with which we are best acquainted are so little particular in their food as to counteract any design we might form upon them ; this objection however, does not apply to the oceanic species,

nor indeed to the others, provided they are taken where the water is pure and saline, and at a distance from rivers and towns. The Opossum Shrimps in common with all the smaller Crustacea, are animals which require the best eyes and instruments to observe properly, and the most detailed sculpture to represent, if therefore the accompanying figures seem minute, they are rude when compared with the originals.

It is in looking closely into the structure of these little animals, that we see the *perfection* of the Divine Artist; nature's greater productions appear coarse indeed to these elaborate and highly finished master-pieces, and in going higher and higher with our magnifiers, we still continue to bring new parts and touches into view. If for instance, we observe one of their members with the naked eye—which may be the utmost stretch of unassisted vision—with the microscope it first appears jointed, or composed of several pieces articulated together—employing a higher magnifier, it appears fringed with long hairs, which on further scrutiny gain a sensible diameter and seem to be themselves fringed with hairs still more minute; many of these *minute* parts are evidently jointed, and perform sensible motions, but what idea can we form of the various muscles which put all these parts in movement, of the nerves which actuate them, and the vessels which supply them with the nutrition essential to their growth and daily expenditure, all of which we know from analogy, they must possess.

The magnified figures in Plate I. and II. may furnish some faint idea of the delicacy and elegance of most of the parts in the Opossum Shrimps, particularly that of the sub-abdominal fins Plate I. fig. 9, of the tail Plate II. fig. 2, and above all, that of the hand of the second pair of feet, fig. 3, which is at once complicated and beautiful, and one of the most elegant microscopic objects that can be conceived.

These, and all the other magnified sketches, with which it is intended to illustrate the smaller subjects in the progress of these memoirs, will tend to show, how absurd it is to think of communicating a clear idea of almost any minute animal without them, and how idle to rest satisfied with representations of the *natural size*, since so much that is worthy to be seen and admired, and which appears necessary to the right understanding of their true nature remains invisible to the unaided sight.

In these little animals when young, and particularly in *Mysis Vulgaris*, the circulation can be better observed than perhaps in any other of the Crustacea. The Heart, which is situated under the centre of the corselet behind, is of an elongated form, (Plate I. fig. 15, *b*;) at its fore part it gives off an anterior aorta, which going towards the head is speedily veiled from the sight by the opacity of the matters contained in the stomach (*a*) and intestine, over which it runs; at its opposite end in like manner it furnishes a posterior aorta, (*c*) which may be traced to the end of the tail; at each side, it further appears to receive a vessel of smaller size, which is probably the united trunks of the pulmonary veins, reconveying the aërated blood from the branchia, again to go the round of the circulation; the pulsations of the heart are so rapid as to resemble vibrations, and together with the blood it is so transparent and colourless, that but for the globules of the latter we should hardly be able to trace the course of the circulation, and which in the figure is represented by little arrows. On observing with attention the termination of the posterior aorta at the end of the tail, a periodical action may be noticed, as if of the opening and closing of a valvular opening on each side, accompanied each time by the filling of the corresponding end of a vessel of considerable size, lying on each side of the intestinal canal, (*d*) these vessels or veins, propel the blood towards the heart by successive



contractions of their muscular fibres, as represented in the figure, and seem to be lost at length in a great sinus or auricle, lying beneath the heart; whether this is really the case or not, remains to be ascertained by dissection, there can scarcely be a doubt however, that the two large veins constitute the *Venæ portæ*, and ultimately send their blood to the Branchia: a somewhat similar appearance, is presented by the venous system of the Caligi, and it is not improbable that in both of these, a valvular communication will actually be found to exist between the posterior commencement of the above described *Venæ portæ* and the abdominal cavity, into which cavity, we may suppose the fluids to be finally poured by the continuations of the arteries, and by the excretories of the alimentary canal, taking into consideration at the same time, that no lacteals or lymphatic system has been proved to exist in any of the invertebrated animals. Whether these appearances, independent of dissection, warrant such a view of the circulation or not, Physiologists will be enabled the better to appreciate its probability, by referring to a somewhat similar contrivance in the molluscous genera of *Aplysia* and *Sepia*, first brought to light by the immortal labours of the first comparative anatomist of the age. See Cuvier, *Memoires pour servir a l'Hist. Nat. des Mollusques*.

If the Opossum Shrimps are the prey of numerous inhabitants of the ocean, they are themselves equally destructive to animals less in size and power, being however rather omnivorous, than strictly carnivorous, seizing and eating every animal substance which the current or the tide carries along with it, and contending like vultures for the possession of the larger masses, nothing tends however to establish more unequivocally their rapacious nature, than the circumstance, that when confined together in a vessel of sea water, they even kill and devour one another.

That the Natural History of the Opossum Shrimps may be rendered as complete as the state of our knowledge permits, and for the satisfaction of the Scientific Naturalist, and the Systematist, the following short description of the Genus has been drawn up, which may be passed over by the general reader.

The *Corselet* or cephalo-thoracic-clypeus, resembles that of the Prawns, without however being remarkably prolonged in front.

The *Eyes* are very large, spreading, and on rather long pedicles.

The *Antennæ* or feelers, consist of an inner and an outer pair; the former, arise from between the eyes, are composed of three robust basil joints, of which the uppermost is short and supports two long multi-articulate setæ, the innermost of these setæ is shorter, and carried straight in front, while the outermost spread out in a lateral direction; the latter or outer pair of antennæ, are placed upon a lower level than the former, originate from the inner side of the anterior lamina or scales, and end in a single long multi-articulate seta, extended downwards and outwards by the animal in swimming.

The *anterior Lamina*, or scales which accompany the outer antennæ, correspond with the same members in the Shrimps and Prawns, but are longer in proportion, and vary in their shape, so as to furnish characters for the distinction of the species.

The *Mouth*, situated as in the Shrimps below the base of the antennæ in front, is provided with a labrum, and with a bilobate under lip, a pair of palpigerous toothed mandibles, and two pair of complicate foliaceous maxillæ or jaws. The Palp has its first joint much abbreviated, the second and third, broad, and strongly pectinate on the margin.

*Feet*: Unlike all the other Macroura, (in which the three anterior pair of feet are disguised and appropriated

to the immediate service of auxiliary jaws) the whole series of feet to the number of eight pair, are thoroughly developed, and further, present us with a very peculiar construction, being all divided to the basil joint or coxæ, into an outer and an inner branch; the former corresponding with the flagrum in the Decapoda, having each a branchia wrapped around their first joint, and ending in a pluri-articulate plumose member, adapted to swimming; the latter or inner division, constitute the true feet, and except in the two anterior pair, end in a many-jointed tarsus surmounted by a small hook, this part in the two anterior ones, being reduced to two joints, of which the extreme joint resembles a kind of hand more or less complicated, particularly beautiful in the second pair, being furnished with a marginal row of jointed spines, most elegantly toothed on their opposite edges.

*Valvular pouch.* Attached to the base of each of the inner divisions of the two posterior pairs of feet in the female, is a large concave scale, strongly pectinate in front, of which the posterior is the outermost, largest, and most concave, lapping considerably over the anterior scale, so as to admit of a considerable extension of the size of the pouch which they form, by meeting each other in front, in order to accommodate its capacity to the growth of the ova and young brood.

In the *male* in place of the valvular pouch of the female, we perceive attached to the inner part of the last pair of feet only, a single small hollow scale on each side, ciliate in front, and provided with a marginal row of slender hooks at the apex: these are probably an appendage of the male organs, which have a similar situation in the Shrimps.

The *Abdomen* or caudal extremity, consists of five joints, furnished beneath with as many pair of fins or natatory members, each fin composed of a *single* elongate flattish scale, plumosely ciliate on its outer margin. We



have in this structure of the sub-abdominal fins, which is not found in any other of the Macroura, another instance, of the modifications which parts undergo in the hands of Omnipotence, so as to adapt them to the peculiar habitudes of the animal ; in Mysis they are *wholly* adapted to swimming, and therefore present the most simple arrangement, but in the other Macroura, as they also serve to receive and mature the ova, they are necessarily larger and more complicate, and are each composed of two articulate branches supported on a common basis.

The *Tail* is composed of five scales, articulated to the last segment of the abdomen ; the middle scale, varying in shape and armature, has been considered by Dr. Leach, as affording the best and most obvious specific characters ; of the lateral scales, the outer ones are the largest, and *also* present considerable difference in shape in the different species.

*Of the different Species of Opossum Shrimp.*

THE species of this Genus as yet known, are but few, and appear to be principally littoral, frequenting the shores and shallow parts of the sea, and the estuaries of rivers.

The *Mysis Fabricii* of Dr. Leach,\* enumerated by Otho Fabricius in his *Fauna Groënlandica*, under the title of *Cancer oculatus*, and very imperfectly figured, (see Plate II. fig. 11, 12) is one of the longest known, and the type of the Genus ; it has been lately more satisfactorily developed by Mons. Desmarests in his work "*sur les Crustacés*" Plate 40, fig. 6. This species is distinguished by the middle scale of the tail being *obtusely* and deeply notched, and at the same time spinous on its edges : the outer scales of the

\* *Mysis*, cauda lamella intermedia apice obtuse emarginata : lamellis exterioribus apice rotundatis. Linn. Trans. Vol. XI. p. 350.

tail, according to Fabricius, are rounded—in Mons. Desmarests figure, they appear obtusely pointed; he also figures the anterior scales as obtusely pointed, serrated, and ciliated all round their margin (as in *M. vulgaris*), and the front of the corselet obtuse. The *Mysis Fabricii* inhabits the sea about Greenland, and constitutes with the *Mysis pelagicus*, the principal food of the whale, (*Balæna mysticetus*.)

Dr. Leach having observed that some of the *species* of *Mysis*, had the middle scale of the tail notched, while in others it remained entire, has divided the Genus into corresponding sections; the former species or *Mysis Fabricii*, together with the two following species, belong to the section with a notched tail, the remainder are referable to his second section.

*Mysis Leachii*, (the *M. spinulosus* of Dr. Leach.\*) The specific names hitherto imposed, not being consecrated by long usage, and being founded in a too partial knowledge of the Genus, such of them as seemed likely to mislead, have been changed for others less objectionable; thus the specific appellation given by Dr. Leach to the present species, would be equally applicable to the most of those with which we are acquainted, the same may be said of the trivial name *flexuosus* employed by Muller. The *Mysis Leachii*, although not sufficiently distinguished from the following species, by the characters assigned in the note, appears to differ obviously in colour and habitudes, and although the former is rather a doubtful guide, yet in the absence of more precise distinctions may be found an useful auxiliary. Colour when alive, pellucid cinereous. Eyes black, red at their base. Laminae of the head with a black longitudinal line and spots, every segment of the body with a reddish rust coloured arborescent spot. Tail

\* *Mysis*, cauda lamella intermedia externe spinulosa, apice acute emarginata: lamellis exterioribus acuminatis, latissime ciliatis. Linn. Trans. Vol. XI. p. 350.

fin spotted with the same colour mixed with black. Discovered by Dr. Leach on the Scottish coast in the Frith of Forth near to Leith, where it was observed in *great abundance* in the pools left by the tide. Found with fry from the middle of June to the middle of July, the females being more numerous than the males. Length  $1\frac{1}{4}$  inch. Dr. Leach refers to this species, the *Cancer flexuosus* of Muller (Zool. Dan. p. 34 t 66), as well as *Cancer multipes* of Montagu, both of which are more probably referable to the following, viz.

*Mysis Chamæleon* \* Plate 2, fig. 1 to 10. This species resembles the former so much in size, and in some of its characters, that it would appear to have been hitherto confounded with it. *Mysis Chamæleon* differs however obviously, in the form of the outer laminæ of the tail, which are but very slightly taper, and very obtuse at the point; the notch in the middle lamina, is furnished with a margin of smaller spines than those on the outer edge which ends on each side in a straight and stout spine; the adjoining edge of the innermost of the lateral scales, is also spinous, although the spines are not very obvious, from the plumose ciliæ which cover them. The anterior scales are very long, nearly linear, obliquely truncated at the end, with a spine at the outer angle of the truncation, and are ciliated *only* along the inner edge and at the extremity. The Clypeus ends in an obtuse point, and has a short spinous point anteriorly at the sides.

Nothing can shew the fallacy of colour in distinguishing the species, more clearly than the variety of tints which *Mysis Chamæleon* assumes, as it occurs here in the river Lee and Harbour of Cove, and which have suggested its trivial name; in the upper part of the river below the City of Cork, it occurs of different shades of grey, inclin-

\* *Mysis*, cauda lamella intermedia margine spinulosa, apice acute emarginata; lamellis exterioribus *subtruncatis*: lamellis anterioribus oblique truncatis, intus ciliatis.



ing at times to black, having invariably the greater part of the anterior scales, inner branch of the superior antennæ and joints of the outer laminae of the tail, black, and the fringe of the scales tinged with pink; lower down, amongst the littoral Fuci, it takes various tints of brown, and those obtained from sites abounding in *Zostera* and *Ulvæ*, present us with green colours of greater or less intensity.

This species has been occasionally met with in the stomachs of Herrings, but has never been observed like the other species in any great numbers together, but scattered and solitary, often associated with *M. vulgaris*. They are extremely quick sighted and wary, darting away or descending tail foremost or retrograde, when any attempt is made to capture them, and more frequently swim with the body in a perpendicular direction, than in any other. In the Lee, they do not appear until towards the latter end of June, but remain until the approach of winter. Length  $1\frac{1}{4}$  inch. That this is the species indicated by Montagu, under the title of *Cancer Astacus multipes*, can hardly be doubted from the sketches given of it in Linn. Trans. Vol. IX. t. 4, fig. 3, and the accompanying description, derived from specimens occasionally found dead amongst Shrimps taken at Salcomb, and in the Kingsbridge estuary: it appears also from the same authority, to have been noticed on the coast of Kent, by Mr. Henry Boys of Sandwich. The figure given by Herbst in his Work on Crabs, &c. for *Cancer flexuosus* Plate XXXIV. fig. 8, natural size, and I, magnified, described Vol. II. p. 114, appears also referable to the present species, although like many of the figures in that valuable work, faulty in the colouring; as with us, he describes it — as existing *thinly scattered* in the Baltic.

*The remaining species have the middle lamina of the tail entire.*

*Mysis vulgaris*.\* Plate I. This species which with us is probably the most common of any of the Opossum Shrimps, does not appear to have attracted the notice of any Naturalist, a circumstance, either owing to their having been taken for young fry of Shrimps, or to the little attention hitherto given to this tribe of animals. When full grown, they are about one inch in length, translucent, and of a greyish colour. The Clypeus ends in an acuminate point in front ; the anterior scales are of a taper form, and ciliated *all round* ; the outer laminae of the tail taper to a point, the middle lamina ends in an obtuse point, surmounted by two short spines. They swim with the body in a horizontal position, and abound in the Lee even up to Cork, from the early part of Spring to the approach of Winter ; during the still period of the tide at low water, they repose upon the mud and stones at the bottom of the river, and as the tide rises, may be observed forming a wide belt just within its margin, the youngest swimming nearest to the shore, the oldest farther out and in deeper water ; they appear to be mostly females, the males being few in proportion. This species contributes towards the food of various young fish, from which they frequently escape by springing up out of the water.

*Mysis scoticus*, the *integer* of Dr. Leach, who discovered this species on the coast of the Isle of Arran, in the estuary of the Clyde, but has not furnished sufficient characters to distinguish it from the former ; like it, the middle lamina of the tail is without any notch at its extremity, but it is a much smaller animal, being but *one-third of an inch* in length, and different in colour and habitudes ; colour, pellucid cinereous, *spotted with black and reddish brown*. Females more abundant. He observes, that at low tides near Loch Ranza in the Isle of Arran, the pools

\* *Mysis cauda lamella intermedia integra, subulata, margine spinulosa : lamellis anterioribus acuminatis utrinque ciliatis.*

were full of this species in the month of August, swimming with its head uppermost, and its eyes spread, making a most grotesque appearance.

*Mysis pelagicus*, This is the species described by Otho Fabricius under the title of *Cancer pedatus*,\* its characters would require to be more clearly pointed out, so as to distinguish it from *M. vulgaris*, to which it appears to approximate. It is described as of a pale colour, one inch in length, and of a *very compressed* form; the anterior scales oblong, pointed, and ciliated; the middle lamina of the tail with two short spines at its extremity united at their base; occupies the surface of the sea at Greenland in great numbers, rarely found either at the bottom or near to the shore; swims *on its back*, and forms together with the *M. Fabricii*, the chief food of the great Northern Whale.

Naturalists who may have opportunities of observing the ill-defined species of *Mysis*, or such as appear new, will do well to attend minutely to the form of the *anterior* scales, the form and armature of the scales which compose the tail, and the shape of the anterior part of the corselet, adding such information in regard to colour and habitudes, particularly their mode of swimming, as may assist in discriminating them.

\* Fauna Groenl. p. 221. *Cancer macrourus*; thorace lævi, compresso, fronte prærupta, pedibus pectoris duplici serie; manibus adactylis; cauda recta apice aculeato, tetraphyllo.





ZOEÆ.

PLATE I. Fig. 1, *a*, *Zoea taurus* magnified, after Slabber. 1, front spine. 2, 3 and 4, three of its four pair of natatory members. *s*, dorsal spine. *s*, 2, spine of the fourth abdominal segment. *f*, sub-abdominal fins.

Fig. 1, *b*, The same animal after its metamorphosis according to Slabber. 1, *a*, interior antennæ. 2, *a*, exterior antennæ. 1, 2, 3, 4, its four members. The want of the spines so remarkable in the former figure, and the changed character of the tail are obvious.

Fig. 3. *Zoea pelagica* magnified, after Bosc. *a*, 1, interior antennæ. *a*, 2, exterior antennæ. *b*, front spine. *s*, dorsal spine. *e*, eyes. *f*, natatory members. *t*, tail.

Fig. 2. *Zoea* observed by the author September 17th 1816, magnified. 1, 2, antennæ. 3, 4, 5, 6, natatory members. *s*, dorsal spine. *s* 2, lateral spines. Fig. 4, *a*, 4, *b*, *Zoea* observed by the author, August 22nd, 1816, magnified. *a*, 1, *a*, 2, antennæ. *f*, natatory members.

Fig. 5. *Zoea clavata* of Dr. Leach.

Fig. 6, *a*, A Crustaceous animal observed by the author, September 19th 1816, S. Lat.  $17^{\circ} 38'$ , Long. W.  $27^{\circ} 12'$ , approximating the second form of *Zoea*, magnified. 1, 2, 3, 4, natatory members. Fig. 6, *b*, its tail more highly magnified.

N.B. On the left hand side of Fig. 2, 4, and 6 the respective animals are represented of their natural size and appearance.

PLATE II. Fig. 1. *Zoea* observed by the author at Cove of its natural size.

Fig. 2. The same magnified. *s*, lateral spines. *s* 1, dorsal spine. *s* 2, front spine. *e*, eyes. *f*, feet or natatory members. *a*, 1, inner antennæ. *a* 2, outer antennæ. *t*, abdominal portion, with rudiments of the sub-abdominal fins. *t*, 1, spinous forked tail—behind the corselet, the rudiments of the limbs of the perfect animal or Crab begin to show themselves.

Fig. 3. One of the mandibles magnified. *a*, toothed extremity. *b*, rudiment of a palp.

Fig. 4. Innermost maxilla magnified. *a*, lobed extremity. *b*, appendage. *s*, ciliated scale.

Fig. 5. Second maxilla magnified. *a*, *b*, *c*, its three divisions.

Fig. 6. One of the anterior pairs of members magnified. *a*, *b*, basil joints. *n*, natatory or swimming division of 2 joints. *f*, inner division of 5 articuli.

Fig. 7. One of the posterior pairs of members magnified, the same letters denote the corresponding parts in fig. 6, but in this the inner division has but 2 articuli.

Fig. 8. One of the outermost pair of antennæ magnified. *a*, *b*, *c*, its three divisions.

Fig. 9. One the inner antennæ magnified. *a*, *b*, its two terminal lobes.

Fig. 10. *a*, Labrum magnified. *b*, under Lip magnified.

Fig. 11. Limbs of the future Crab disengaged from beneath the clypeus on one side, magnified. *a*, chelate member. 1, 2, 3, 4, other members.

Fig. 12. Member anterior to the claw, the rudiment of the outer pedimaxilla.

## MYSIS.

PLATE III. Fig. 1. Side view of *Mysis vulgaris* magnified; the straight line near it expressing its real length when fully grown. 1 *a*, innermost seta of the right superior antenna. 2 *a*, its outermost seta. 3 *a*, setæ of the inferior antennæ. *s*, anterior scales. *e*, eye. *p*, palpi. 1 *f*, prehensile, or innermost rows of feet. 2 *f*, natatory or exterior feet. 3 *f*, sub-abdominal fins. *u*, valvular sub-pectoral pouch, or receptacle of the young in the female. *c*, the cephalo-thoracic-clypeus. The five-jointed posterior part of the trunk, and the tail require no figures to make them obvious.

Fig. 2. The anterior part of the animal from above, more highly magnified, shewing the taper pointed form of the anterior Scales, the form and position of the superior antennæ, with regard to the inferior and exterior pair, the pointed termination of the Clypeus in front, and the Eyes.

Fig. 3. The Tail from above, magnified in the same degree with fig. 2, for the purpose of shewing the form of the laminæ, and particularly the middle one, with its spinulose margin.

Fig. 4. One of the Palpi from within, very highly magnified. *a*, basil joint, by which it is articulated to the mandible, *b* middle joint, *c* last joint, ending in a strong spine and a row of mucronated clavæ, and having a row of hooks along one margin, and a double decussating row of bristles along the other; to do justice to the curious and complicated structure of this one joint it would require the entire plate to itself.

Fig. 5. The basis of one of the superior antennæ in the *male*, to show its brush-like appendage; the setæ have been cut off short; *x* indicates the point of attachment to the animal.

Fig. 6. One of the first pair of feet, (the left) highly magnified, *x* point of attachment. *a* its inner division. *b* its outer division abbreviated, as being similar to those of all the other feet. *g* its branchia.

Fig. 7. One of the second pair of feet, (the left) highly magnified, *x* point of attachment. The same letters indicate the analogous parts in fig. 6, 7, and 8. In this figure, the outer or natatory division of the limb is fully represented.

Fig. 8. One of the last (or of the eighth) pair of feet, (the left) highly magnified; shewing the pluri-articulate tarsus of the inner division, consisting of about ten joints, and ending in a short claw. The 3d, 4th, 5th, 6th, and 7th pair of feet are exactly similar. Fig. 12, shews the tarsus and claw, as they appear when the young animal first emerges from the maternal pouch.

Fig. 9. One of the sub-abdominal natatory fins, very highly magnified, consisting of a single joint, and very beautifully feathered on its edge.

Fig. 10. Figures of the natural size and magnified, shewing the progress of development in the Ova. *a*, ova when first received into the valvular pouch. *b*, side and front views of the elongated ova, with its two pair of lateral projections. *c*, side view of the embryo, the tail considerably elongated, forked, and bent backwards, and together with the lateral members, slightly ciliated. Fig. 11. The Embryo of the natural size, and magnified,



approaching to maturity; its pedunculate eyes, two pair of antennæ, clypeus, feet and posterior extremity almost fully developed.

Fig. 13. The last or eighth pair of feet in the *male*, magnified.  $\times$  indicates the situation of those organs in the male which occupy the place of the female receptacle. *fig.* 14. One of these organs (the left) more highly magnified,  $\times$  its point of attachment.

Fig. 15. Magnified sketch of the Heart and great blood vessels, the arrows indicating the course of the circulating fluid. *a*, the stomach, lying over the anterior aorta, and obscuring its further course towards the head. *b*, heart. *c*, posterior aorta. *f*, indicates the line of the posterior part of the clypeus. *d, d*, presumed venæ cavæ. *e, e*, what seems to be a receptacle placed beneath the heart. The two *lateral* vessels which are seen entering the heart, are probably the trunks of the pulmonary veins, coming from the branchiæ. The great transparency of this species, (*M. vulgaris*,) particularly when young, permits all this to be seen without dissection.

N. B. In order to avoid the unnecessary multiplication of plates, and as the *remaining members of the mouth, and the valvular pouch*, are similar in *M. Chamæleon*, these parts have been copied after *that* species, and will be found in the following Plate.

PLATE III. Fig. 1. Anterior extremity of the female *Mysis Chamæleon*, highly magnified. 1 *a*, superior antennæ. 2 *a*, inferior antennæ. *c*, corselet. *e*, eye. *s* anterior scales.

Fig. 2. Posterior extremity of the same somewhat more magnified, to shew the peculiar form and armature of the middle scale, as well as the shape and admirable plumose fringe of the outer ones.

Fig. 3. The last joint of the inner division of the second pair of feet, very highly magnified; a small circle on the left indicates its natural size, and the line on the right the length of the full grown animal. This very beautiful member, may be observed to end in a strong spine above, to have its front armed with a gradation of hooks, its back bristly, and its margin surrounded by a graduated row of bi-articulate flattish spines, most elegantly toothed on their opposite edges. It is hardly possible to do justice in such a sketch, to the complication, and extreme elegance of this wonderful little hand.

Fig. 4. One of the first pair of maxillæ, highly magnified, from the right side, (as seen from within,) foliaceous, complicate, and variously ciliated: *f* the analogue of the flagrum, placed at its outer edge.

Fig. 5. One of the second pair of maxillæ, from the same side, (also from within,) its middle division with a double row of teeth, its inner division, ending in three denticulate spines. *f*, analogue of the flagrum.

Fig. 6. Mandible and Palp of the left side, highly magnified, as seen from without. *a*, fulcrum for muscular attachments: *m*, acting part of the mandible and its toothed extremity. *p*, Palp, (as in Plate I. fig. 4) attached to the angle of the mandible.

Fig. 7. Labrum, highly magnified.

Fig. 8. Labium, highly magnified.

Fig. 9. The outer or *posterior* valve of the maternal pouch, from the left side, magnified,  $\times$  point of attachment; front edge strongly ciliate or pectinate.

Fig. 10. The inner or *anterior* valve of the maternal pouch, from the same side as the former, magnified,  $\times$  point of attachment.

Fig. 11. *Mysis Fabricii* from the Fauna Groenlandica. Fig. 12, tail of the same.

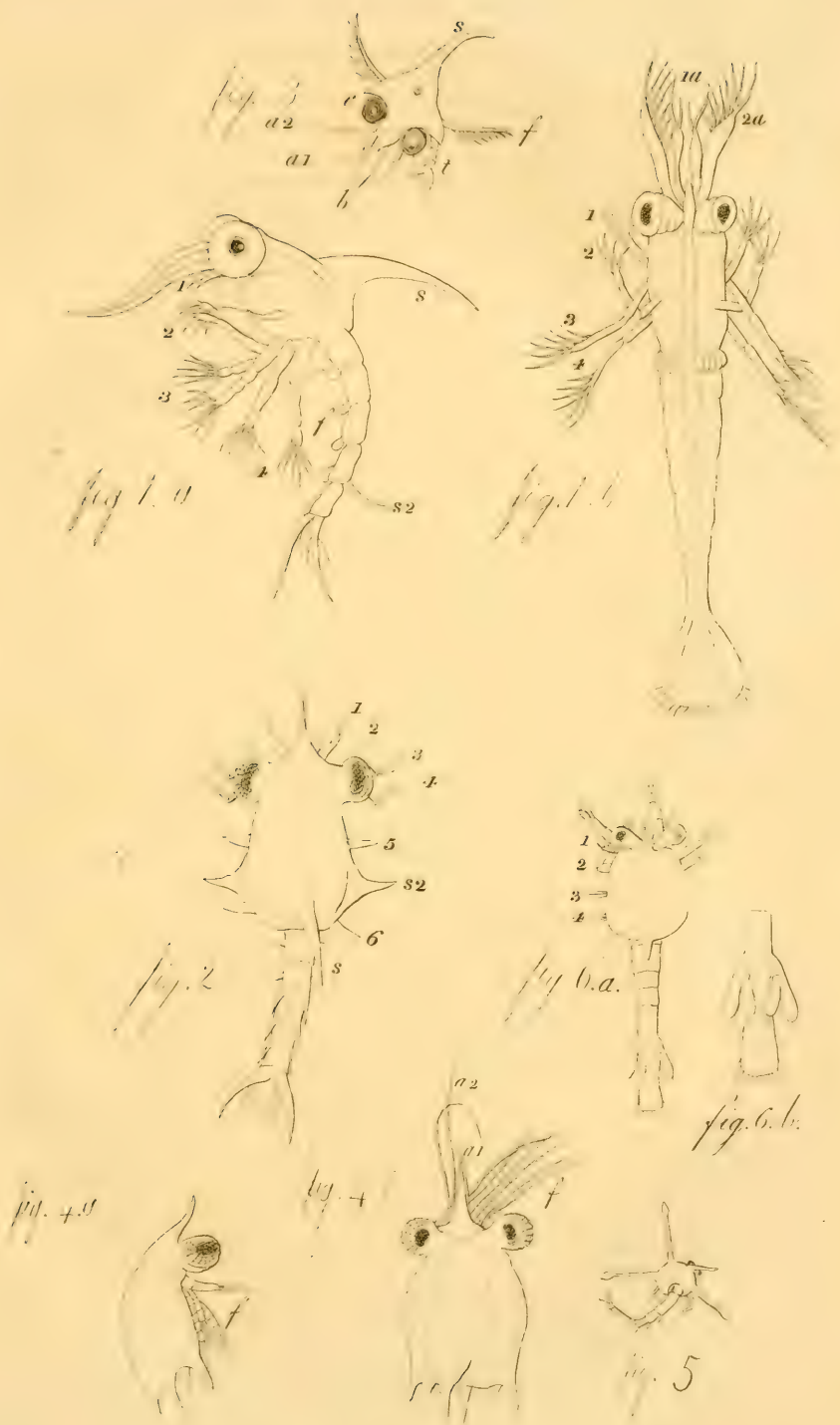
#### ERRATA.

Page 8, line 4.... *for* fig. 1, 6, *read* fig. 1. b.

16, " 6.... from bottom, *for* *Lacerta* *read* *Salamadra*.

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NYSIS.





Pl. III.



MYSIS.  
*J. L. A. fort.*



## ZOOLOGICAL RESEARCHES.

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### MEMOIR III.

*On the Luminosity of the Ocean, with descriptions of some remarkable species of Luminous Animals (Pyrosoma pig-mæa and Sapphirina indicator) and particularly of the four new genera, Nocticula, Cynthia, Lucifer and Podopsis, of the Shizopoda.*

THE animals of which we are about to treat, contributing largely to the phosphorescence or sparkling of the sea, the following general observations relating to that subject, may not be deemed unacceptable or out of place.

Of the various Luminous Phenomena which nature offers to our notice, that afforded by the luminosity of the ocean, is one of the most remarkable, and has consequently attracted a good deal of attention from Philosophers and Naturalists: having ever been alive to this interesting appearance, in various seas and regions, I feel myself authorized to offer the following general observations upon the subject.

(A.) The most common and familiar kind of luminosity is that, which, when the water is slightly agitated by the winds or currents, shews itself, in scattered sparkles in the spray of the sea, and in the foam created by the way of the ship; these sparkles or luminous points, vary in magnitude, and often continue to shine for some moments,



as they pass the sides of the vessel, or follow in the track ; the kind of light exhibited by this variety, is perhaps more brilliant and condensed than that of any of the others, and very much resembles every way, that of the red, gold, and silver rain of the Pyrotechnist.

(B.) The former kind of luminosity, is not unfrequently accompanied by flashes of a paler light of momentary duration, and independent of the light with which these strike the visual organs, often illuminate the water to the extent of several feet ; these are more or less vivid, according to the distance of the observer, and the depth at which they make their appearance. This kind of luminosity, resembles extremely the lightning so often seen in tropical regions, and which presents itself in diffused flashes of light, now issuing from one mass of clouds, now from another, in constant succession over the whole face of the heavens.

These modifications of the luminosity of the ocean, are common to every part of it in the more temperate and tropical regions. A variety of the last kind, (B) in which these larger masses of phosphoric light possess a greater degree of permanence, has been noticed by Spallanzani in the Mediterranean, and may occur in other situations, but has never been seen by the author. “ If” says he “ in the beginning of the night we enter the strait of Messina (October was the month in which these observations were made) in a low bark or boat coasting near the land, where the water is perfectly calm, the Medusæ, which are usually very numerous there, begin to shine with a light, which as the darkness increases, acquires intensity and extent, every medusa resembling a bright torch, that may be seen for some hundred paces around ; and on approaching it, the brilliant phosphorus shews the form of the body. This light, when the evening twilight is extinct, is of a lively white, which strikes the eye even when the animal is five-and-thirty feet below the surface. As the medusa, by its oscillation, transfers itself from place to place, so the light

is variable and is stronger in the systole than in the diastole. Sometimes it continues for a quarter of an hour, half an hour, or more; but at other times it suddenly becomes extinguished, and does not re-appear till after a considerable interval. These luminous medusa are called *Bromi* at Messina—at the Lipari islands *candellieri di mare*.” (*Travels*, vol. IV. p. 229.)

(C.) A third kind of luminosity, is peculiar to gulfs, bays, shores and probably to parts of the ocean where the bottom is at no great distance, in all the warmer regions of the globe; here the luminosity is so predominant that the slightest agitation of the waves, the passage of fish, the movement of the oars, or the way of a ship, produces a diffused pale phosphorescence, and under some of its modifications, resembles a sea of milk, or rather of some metal in a state of igneous liquefaction.

Passing for the moment some less common and peculiar kinds of luminosity, it may be observed, that all the various foregoing appearances, so interesting and often alarming to those who travel by sea, have been ascribed at different periods and by different individuals to a variety of causes, viz. *a*, the absorbed light of the sun, disengaged by the friction of the waves; *b*, electricity, excited by the same means; *c*, phosphoric matter diffused through its mass; *d*, lastly, to luminous marine animals. The investigations of the practical Naturalist have tended to set aside all these, with the exception of the last, which would appear to be the sole cause of this curious phenomenon, in all the modifications above stated, as well as in every other instance: the first and third kinds (A & C.) being attributable to minute crustaceous animals, the smaller medusæ and molluscæ, and perhaps some annelides, modified in degree, by the animalecules being more or less scattered, and the prevalence of particular species: the second kind (B.) as already explained, appears to be the production of medusæ of a larger size, of which as yet, but two species have been observed to be

possessed of this curious property, viz. medusa pellucens of Sir Joseph Banks, (*Philos. Trans.* 1810, pl. XIV, fig. 3) and the medusa Spallanzanii not hitherto figured; both of these belong to the genus *Aurelia* of Lamarek, of which we have many species not luminous.

The third kind of luminosity, (C) is comparatively of rare occurrence, and that which is the most alarming in appearance; I had but once an occasion to witness and to investigate it as it occurs in the Mediterranean. Returning from a fishing party *late* in a still evening across the bay of Gibraltar, in a direction from the Pomones river to the old Mole, in company with Dr. Drummond, (now Professor of Anatomy to the Belfast Institution) and a party of naval officers, the several boats, although separated a considerable distance, could be distinctly traced through the gloom by the snowy whiteness of their course, while that in which we were, seemed to be passing through a sea of melted silver; such at least was the appearance of the water, displaced by the movement of the boat and the motion of the oars; the hand, a stick, or the end of a rope, immersed in the water, instantly became luminous and all their parts visible, and when withdrawn, brought up numerous luminous points less than the smallest pin's-head, and of the softest and most destructible tenderness, appearing on a closer inspection out of the water, like hemispheric masses of a colourless jelly, evidently however, organized and included within an enveloping tunic; these were probably some species of minute medusa. This appearance however, is probably caused by several different animals; thus the animal discovered by Mr. Langstaff on a voyage from New Holland to China, appears to have been the linked young of some *Salpa*, while that observed by Riville is undoubtedly a crustaceous animal of the ostracoda. The former, as cited by Professor Macartney in his valuable paper on luminous animals, (*Philos. Trans.* 1810,) states "In going



from New Holland to China, about half an hour after sunset, the sea presented a milky appearance, the ship seemed to be surrounded by ice covered with snow, no bottom was discovered on this occasion with 70 fathoms of line—a bucket of water being hauled up, and examined in the dark, discovered a great number of globular bodies, about the size of a pin's head, linked together. The chains thus formed did not exceed three inches in length and emitted a pale phosphoric light. By introducing the hand into the water, several chains of the luminous globules were raised—the globules, were so transparent that they could not be perceived when the hand was taken into the light—this extraordinary appearance of the sea was visible for two nights. As soon as the moon exerted her influence, the sea changed to its natural dark colour, and exhibited distinct glittering points as at other times.” (*Philos. Trans.* 1810, p. 269, 270.)

Riville's description of this phenomenon is as follows. “The surface of the sea gently agitated, was covered with little stars, each wave which broke around the vessel gave out a very lively light, and like in colour to that of a cloth of silver electrified in the dark. The waves, which seemed from time to time to be confounded one with another, formed at the horizon a plain covered in appearance with snow, and the track of the vessel was of a lively and luminous white, strewn with brilliant and azure coloured points.” This was in a voyage to India when off the Malabar coast, in N. Lat  $8^{\circ} 47'$ , and Long. E. of Paris,  $73^{\circ}$  at 9 o'clock, P. M. on the 14th July, 1754. (See Godeheu de Riville in *Mem. de l'Acad. des Sciences—Savans Etrangers*, tom. iii, p. 267. Observations on two Entomostraca of which he gives the figures.) Latreille thinks the first of these must be a species of *Lynceus*, but as no species of that Genus has been discovered out of *fresh* water, this is to be doubted; it may be satis-

factory to know that some new animals of this tribe (Ostracoda) have been detected in our own seas and will be made known in some future Memoir. Riville describes the phosphorescence as residing in what he calls a bluish liquor, which exuded from the animal, giving the same luminous appearance to the water, and which lasted several days; but on due examination, this blue matter was found to be a moveable congeries of globules, lodged within the posterior part of the shell of the animal, of a blue colour, but which became yellowish and dark as the animal approached its end; these globules Latreille imagines to have been its eggs.

To the above may be added the testimony of Captain Horsburgh, (as it relates in all probability to the same animal,) as extracted from the notes he gave to Sir Joseph Banks. "There is (says he) a peculiar phenomenon sometimes seen within a few degrees distance of the coast of Malabar, during the rainy Monsoon, which I had an opportunity of observing at midnight: the weather was cloudy and the sea was particularly dark, when suddenly it changed to a white flaming colour all around. This bore no resemblance to the sparkling or glowing appearance I had observed on other occasions in seas near the equator, but was a regular white colour, like milk, and did not continue more than ten minutes. A similar phenomenon, (he adds) is frequently seen in the Banda sea," &c. (Professor Macartney *Philos. Trans.* 1810.) More lately this appearance has been noticed by Captain Tuckey. "After passing Cape Palmas and entering the gulf of Guinea, the sea appeared of a whitish colour, which encreased together with its luminosity until making Prince's Island, so that at night the ship seemed to be sailing in a sea of milk. To discover its cause a bag of bunting, its mouth extended by a hoop, was kept overboard and collected *vast numbers* of animals of various kinds particularly pellucid Salpæ with *innumerable* little crustaceous animals of the Scyllarus Genus (Squillæ) attached

to them, to which I think the whitish colour of the water may be principally ascribed. Of Cancers we reckoned 13 different species, eight having the shape of crabs, and five that of shrimps." *Tuckey's Voyage to the Congo.*

These are all the recorded instances of this very remarkable kind of phosphorescence having been seen; it is therefore almost unnecessary to say, that the attention of voyagers should be given to it whenever it is met with, and to the animal or animals which appear to cause it, none of which have been satisfactorily described; this may be done by preserving some of the water until next morning for due investigation, or by straining a portion of it and preserving the filter in a well-closed vessel of common spirits, until subjected to the scrutiny of some qualified naturalist.

Independent of the animals which operate in a more general way in the production of the luminosity of the ocean, there are some others which present a peculiar character, and are moreover of a local nature, at least they have never been observed beyond certain circumscribed limits; two very remarkable kinds of luminosity of this sort have as yet been noticed.

The first of these (D.) presents itself to the astonished voyager, under the appearance of thick bars of metal of about half a foot in length ignited to whiteness, scattered over the surface of the ocean; of these, we perceive some to assume the luminous state and continue it as long as they remain in view, while in others, we witness the luminosity to decline and disappear; the greater number of these apparently incandescent masses pass close to the sides of the vessel, or follow in her wake, their phosphorescence being called into activity by coming in contact with her prow or bottom, as that of such as are more distant appears to be, by the conflict of the waves. This appearance results from the *Pyrosoma atlantica*, a compound animal resembling a hollow cylinder of a transparent gelatinous substance, open at one end, and papillary on its



surface, belonging to the class of Tunicata, and first discovered and figured by Messrs. Peron and Le Sueur, (*Voyage aux Terres Australes*, tom. I, p. 448, pl. 30, fig. 1. and *Annales de Muséum*, tom. 4, p. 440. A figure of it may be seen in Shaw's Zoological Lectures, plate 127. The light which this animal yields, appears to pervade its whole substance, and when examined near at hand, varies in intensity and in shade, often exhibiting a very beautiful phosphorescence of a blueish or greenish tinge, like a pale sapphire or aquamarine as it gradually fades away; agitation or friction renews it as in other luminous animals as long as it continues to exhibit signs of life, but it is most vivid, when the animal is first drawn up, and at length can scarcely be called forth by the rudest treatment. As we observed this interesting animal, with Milbert's florid description at hand (*Voyage Pittoresque à l'Isle de France*, tom. I. p. 110.) I can aver, that the red, aurora, and orange colours, did not present themselves to the eyes of any of our numerous party, who were nevertheless, highly gratified at the sight of so brilliant and singular a creature.

This phenomenon may often be witnessed by vessels bound to India or the eastward of the Cape of Good Hope, occurring in the calm latitudes near to the Line. Peron's observations led them to restrict the limits of its habitation between the 19° and 20° of Long. W. of Paris, and the 3° and 4° of N. Lat. We first fell in with the *Pyrosoma* however, in N. Lat. 12° and carried it with us all the way to the Line, between the Longitudes of 16° and 20° W. Ships generally cross the Equator to the Westward of W. Long. 20° to avoid the calms which prevail nearer to the African coast, those therefore, which from necessity or choice pass to the eastward of this longitude, may expect to meet with the *Pyrosoma*, within the limits indicated above. As we approached the Equator, a smaller species made its appearance, intermingled with the former; in this, the luminosity is more condensed about the mouths



of the little animals which compose it, and as these are not placed irregularly, as in the larger species, but are arranged in rings or whorls, it puts on a very beautiful appearance, resembling a gem studded with the diamond or opal, Plate 8, fig. 3. This species did not exceed an inch in length, had about seven or eight rows of animals, and a somewhat contracted aperture; this species I would designate by the specific appellation *pygmæa*. Subsequent to the discovery of the *Pyrosoma atlantica*, two other species of this very remarkable Genus have been detected in the Mediterranean, viz. *Pyrosoma elegans*\* resembling my *P. pygmæa*, and *Pyrosoma gigantea* † having a greater degree of affinity with *P. atlantica*, but having the mouths of many of the animals furnished with a foliaceous appendage probably conducing to the locomotion of the aggregate; this species exceeds a foot in length. We have yet to learn whether these species are luminous, but they have furnished Naturalists with the means of becoming acquainted with the very peculiar structure of *Pyrosoma*, which will be found amply developed by the authors above cited. I cannot dismiss this subject without adverting to a point connected with the economy of these animals which seems to declare that the Atlantic species have been created for the locality where we find them; possessing no power of locomotion in themselves, they are driven to and fro by the light and variable winds which are known to prevail to the north of the equator, and repressed from emigration into either Temperate zone by the constant action of the Trade winds on the North and South: the Mediterranean species on the other hand, inhabiting a sea influenced by tides, and by winds and currents altogether variable and often rude, are furnished with exterior appendages which

\* Le Sueur, Nouv. Bull. des Sciences, Juin 1813, p. 283. pl. 5 fig. 2; and Mai 1815, pl. 1, fig. 4.

† Idem, Mai 1815, p. 80, pl. 1, fig. 1-3, 5-13. and Journ. de Phys. Juin 1815, fig. 1-3, 5-13. Savigny, Mem. sur les anim. sans Vertebres, Memoir 3d pl. 4. fig. 7. and pl. 22. 23.

seem to have no other use, unless we suppose them to be given for the purpose of locomotion. For a confirmation of this circumstance we naturally look to those Naturalists who may find themselves favorably placed, to make observations upon living Pyrosomæ.

The other kind of luminosity of a more local nature, (E.) is that which presented itself to the observation of Captain Horsburgh, a gentleman richly entitled to National Honours and to the gratitude of posterity, for his valuable contributions towards the safe navigation of a large portion of the trackless Ocean. His example in the present instance deserves to be imitated. At sunrise on April 12, 1798 in the Arabian Sea, he perceived several luminous spots in the water, which conceiving to be animals, he *went in the boat*, and caught one: it proved to be an insect somewhat resembling in appearance the wood-louse, (*Oniscus*) and was about one third of an inch in length. When viewed with a microscope it seemed to be formed by sections of a thin cutaneous substance. — “During the time that any fluid remained in the animal it shone brilliantly like the fire-fly.” Taken from his notes given to Sir Jos. Banks, as quoted by Prof. Macartney, *Phil. Trans.* 1810. who has appended to his paper, Pl. XV. f. 4, an engraving of the animal copied after a pen-sketch by Captain Horsburgh. Having had the good fortune to meet with this same animal (Pl. 8. f. 2. a. b. c.) by day light while in soundings near to the Belliqueux Shoal, which lies off the South extreme of the island of Madagascar, and again on the Agullas Bank near to the Cape of Good Hope, August 9th, 1816, I am entitled to say that it is no *Limulus* as suggested by the learned Professor, and although not sufficiently scrutinized by me to determine its actual structure, is an animal which it is impossible to associate with any other genus of the Crustacea. Individually I feel under great obligations to this beautiful little animal, which by its splendid appearance in the water induced me to commence the use of a muslin

hoop-net, which when it failed to procure me a specimen, brought up such a profusion of other marine animals altogether invisible while in the sea, as to induce a continued use of it on every favorable opportunity. The *Sapphirina indicator*, which is the name I propose for this animal which is so beautifully luminous by night, by day resembles the finest Blue Sapphire in colour, with the opalescence of the Moonstone or precious Opal, and although but one third of an inch in length, this colour ( which is thence probably a modified phosphorescence) pervades the surrounding element so as to give the animal the appearance of being round and of the size of a livre or rupee when seen from the deck of a vessel, appearing larger in proportion to its distance below the surface. When turned upon its back, Pl. 8. f. 2. c. it presented an opaline hue, and the appearance of numerous radii or members from each side of the segments which compose its body, together with a trifid colourless process f. 2. b. c.  $\times$  occasionally projected by the animal at the sides of the corselet; these various members assumed at times a rapid movement backwards and forwards, but as the weather was dark, coarse and unfavorable to minute investigation, I could not succeed in developing the structure of these parts at the moment; but by placing several of the animals in the slides attached to my Microscope hoped to be able to do so at some more favorable juncture, in this however I was disappointed by the slides having been subsequently lost while the Instrument was undergoing some alterations at an Opticians in London. If this animal is elegant when viewed by reflected light, it puts on a still more extraordinary appearance when the light is transmitted through its body to the eye of the observer; by a direct light of this kind it resembled the Fire-stone, with tints of yellow, and by a less vivid and indirect illumination it assumed varied intermingled tints of orange, rose, blue, and green of a metallic splendor, and impossible to imitate. The body of the *Sapphirina*, which



is much depressed, is composed of nine segments; of these, the anterior is largest, constitutes the clypeus, and presents towards its middle part the appearance of a pair of proximate eyes; the posterior segments diminish in width as they approach the opposite end or tail, and the last of them is terminated by two elliptic fins or scales, setaceous on their outer edge and having a central longitudinal nerve or rib. The Sapphirina swims in all directions with apparent ease by the motion of its tail, and often darts away by some sudden effort of its concealed members. There can be no doubt of this animal belonging to the Monoculi of Linnaeus, and most probably to the same family with Cyclops, a relationship which will be more apparent, when we become acquainted with the structure of a nondescript member of it lately detected in our own seas, and which it is intended to develop in a succeeding Memoir. The geographical distribution of the Sapphirina appears to be limited to the seas situated to the north and west of a line drawn from the Cape of Good Hope to the southern extremity of the Island of Ceylon.

There is yet another of these luminous Phenomena which merits a moment's consideration, viz. that which in violent storms at sea, makes its appearance in a luminous patch or ring upon the masts and on the windward yard-arms, gradually mounting up the former as the storm increases in violence; this appearance most probably results from the minute luminous animals being carried up and lodged there by the spray of the sea, which, while it continually furnishes a fresh supply and excitement, gains gradually a higher range, until the storm is at its height. Having only sailed in *large* Vessels, I have frequently observed an appearance of this kind on the lower masts and windward rigging; this has in all likelihood been often confounded with the Fire of St. Elmo, which would seem to be a purely electrical phenomenon, and is described as resembling a radiant star or flame playing about the very summits of the masts.



Philosophers have naturally been anxious to discover the *object* of this curious property in animals, which is so little obvious, that they have not hitherto been able to bring forward any explanation which applies to more than a limited number of cases ; thus in luminous *Insects*, which are all of them crepuscular or nocturnal, it has been supposed to serve the purpose of bringing the sexes together, which is extremely probable ; but when we investigate this property as it occurs in *marine animals*, this is evidently not the true solution, as the major part of them have the sexes united, are destitute of visual organs, and shine equally in their young or larva state. From the vast number and variety of these last, and from observing all such to be more or less translucent, added to the circumstance that the luminosity seems to be in every case intimately connected with their irritability, and is apparently under the controul of the individual, we should be tempted to consider it as an evidence of volition, or the transmission of the nervous influence in a condensed form, to some of the organs of the animal requiring an encreased energy to counteract the unusual external force which operates upon them for the moment, for it may be remarked, that it is in general the contact of other bodies, or the concussion of the waves which calls the luminous property forth ; we must give up this explanation however, when aware, that numerous translucent marine animals do not shew any luminosity, and that it is not found but in *particular species* of the same Genus. Meditating upon this subject, I think it not improbable, that the Deity, who has done nothing in vain and whose Omniscience extends to every epoch, foreseeing that man would invent the means of tempting the trackless ocean, and explore the most distant regions of our Planet, has given it as one means of rendering his nights less gloomy, and of diminishing the number of his dangers ; especially if we consider, that this luminosity is seen only in the night season, is vivid in proportion to the darkness, disappearing

even before the feeble light of the moon, and also, that it increases with the agitation of the sea, so that during the prevalence of storms it greatly diminishes the dense gloom which at such times is often impenetrable to the moon or stars, throws such a light upon the Ship and rigging as to enable the sailors to execute their allotted tasks with certainty, and at all times points out to the cautious mariner the lurking danger of sunken rocks, shoals, and unknown coasts, by the phosphorescent or snowy appearance which it gives to the Breakers, so as to render them visible at a considerable distance ; where again the diffused luminous appearance (described under C.) of the Sapphirina indicator is seen, he may be certain that he is in soundings, and probably at no great distance from some fatal spot.

In the terrestrial animals which are luminous, we perceive organs especially provided to secrete and treasure up the luminous matter, and transparent spots to permit the transmission of the light ; in marine animals nothing of this kind has ever been discovered, and their bodies appear so homogeneous and transparent, that wherever the focus of light may be, when excited, it seems to pervade, and as it were light up the whole body of the animal. Dr. Smith indeed, during the interesting voyage of Captain Tuckey to the Congo, observed that the luminosity of a kind of shrimp appeared to emanate from the brain, which “ when the animal was at rest resembled a most brilliant amethyst about the size of a large pin’s head, and from which, when it moved, darted flashes of a brilliant silvery light ” *Tuckey’s Voyage*. Spallanzani with his usual ingenuity and perseverance, resorted to a variety of expedients to ascertain where the luminous property resided in the phosphorescent medusæ of the Mediterranean, and came to the conclusion, that it is confined to the viscid excretion which is found towards the margin of the umbel, on the larger tentacula and “ on the surface of the purse communicating with that aperture of the umbella which is perhaps the mouth of the animal. ”

All these parts, he observes, become luminous on being touched—rendering the fingers luminous, “and if this humour be scraped off with a knife and put into a glass filled with (fresh) water or milk and stirred with the finger or a spatula, both those fluids will become phosphoric, which they will not when the moisture expressed from any other part of the medusa is mixed with them” *Travels*, vol. IV. p. 242-248. Query—Is the luminosity in the viscid excretion, or in the animalculi which adhere to it, and which probably constitute the food of the animal?

*Of Some New Genera of Luminous Crustacea.*

IF we sometimes and at particular seasons witness the sparkling appearance of the sea in the Temperate Zones, within the limits of the Tropics it may be said to prevail all the year round, and that in a remarkable degree, soon after the sun dips beneath the horizon and that the light of the moon is withdrawn. The individuals of the first of the following Genera constitute a principal cause of this luminosity, to which the others also contribute,—not that this phenomenon, in the situation indicated, results solely from luminous Crustacea, for a vast number and variety of Mollusca, &c. have been ascertained to lend their aid towards it. Although the muslin towing net cannot be used with effect in detecting these minute animals when the progress of a vessel is considerable, yet we can often succeed in capturing a luminous point now and then, by suspending it by means of a very short line over the stern in such manner as that it may just trip along the surface or dip a little into the water on the heave of the sea, taking care to hawl it quickly up when any of them appear to be intercepted by it, and removing them with a camel-hair pencil, into a glass vessel filled with sea water for examination the following morning: if the observer is either



unprovided with a microscope, or incompetent to the task of developing the structure of such small objects as are thus procured, they can be preserved in a closely corked phial of spirits unchanged for any length of time, with the exception of such as *feel* soft, gelatinous and yielding, which being species of Medusæ, cannot be kept from dissolution by any of the means hitherto tried, and if mixed with the others might tend to cause the corruption of the whole ; these therefore, should be carefully separated and rejected, or what would be still better, every kind might have a phial to itself. When the luminous animals are observed to be remarkably numerous, they may also be conveniently obtained by drawing up a bucket-full of the water, from which they may be separated by means of a small wire hoop or open spoon covered with muslin.

### Genus 1.

#### *Nocticula, or Luminous Shrimp.*

THE animal which forms the type of this Genus, was first discovered by Sir Joseph Banks, in the passage between Madeira and Brazil. Observing that the sea was particularly luminous, he had some of the water drawn up in a bucket, and found that the sparkling appearance was owing to the present animal, which he therefore named *Cancer fulgens*. (Macartney *Phil. Trans.* 1810.) The drawing which Sir Joseph caused to be made of it, and published in the paper above referred to (Pl. XIV. f. 1 and 2) and copied Pl. 5 f. 2 although perhaps not remarkably exact, shews that it approximates the Opossum Shrimp (*Mysis*) in figure, and in the number and structure of its members. Having had an opportunity of taking numerous individuals of the Luminous Shrimp, in my homeward passage from the Mauritius, I have been enabled to figure it with more care, Pl. 5 f. 1 : Making due allowance for drawings made at sea of such minute



objects, I am inclined to consider these as identical, it may be observed, that neither show the natatory division of the members, which from the great transparency of the animal, their position, and not being suspected, wholly escaped observation; what strengthens the probability of their identity, is, that those obtained by the author were found in the track necessarily pursued by Sir Joseph Banks towards Rio Janiero, viz. between the Latitudes of  $5^{\circ} 25'$  S. and  $29^{\circ} 30'$  N. and West Long.  $17^{\circ} 18'$  and  $32^{\circ} 55'$ , on the 6th 12th and 25th September, where they were in considerable abundance, widely distributed, and uniform in character.

The *Nocticula Banksii* or Luminous Shrimp, resembles in figure the animals of the Genus *Mysis* described in the former Memoir, as they do also in structure, and particularly in the number and formation of the members, which consist of eight pair, and which, on due investigation will no doubt be found cleft or divided into two branches as in *Mysis*, so that was it not for the very different construction of the sub-abdominal fins, it would merge in that Genus; this peculiarity however, is undoubtedly generic, and argues a somewhat different mode of life and means of rearing their young, which last, is probably effected after the same manner as we witness in the true Shrimps, where the ova are appended to the sub-abdominal fins, which by their great length and more complete developement they are not only fitted to accomplish, but to add considerably to its power as a swimmer. As amongst the individuals taken, none presented the remarkable character of the *pouch* of *Mysis*, this would appear to authorize the opinion of *Nocticula* breeding after a different manner, however as it would be highly desirable to ascertain this point by an examination of the female in the breeding season, I commissioned several gentlemen going to the West Indies, to procure some of these animals, furnishing each of them with a small hoop-net, a line, and phials. One of these alone communicated the result of his exertions (Major Gilland on his outward

voyage in 1825,) which amongst a variety of Gammari, Cyclops and other marine animals, produced a solitary specimen, which on investigation, proved to be the type of an approximating Genus, (Cynthia) so that it still remains a desideratum to know in what manner the ova are disposed of and hatched after exclusion from the Ovarium, and whether the animals undergo any change or metamorphosis during their progress to maturity.

This luminous animal, which is the only species of Nocticula as yet known, I have named Banksii from its first discoverer, and as a small tribute to a Naturalist possessed of affluent circumstances, yet whose zeal for the cultivation of knowledge led him to expose himself to the greatest personal risk and inconvenience—to devote his fortune and his whole life to this object, and finally to bequeath his valuable and accumulated stores of knowledge to posterity. It may be truly averred that no one individual was ever so instrumental in promoting and encouraging every species of knowledge and every useful art : the recollection of these circumstances, of the admirable arrangements which he made for this purpose, and of his obliging condescension and affability to all, must cherish a grateful remembrance in the breast of every Philosopher and Naturalist of the same era, while his bequest to the Nation which he adorned, will secure to him the admiration of posterity, more than any other Monument that could be erected to his memory.

The following description of the Luminous Shrimp, has been copied from my journal.

*Corselet* like that of the shrimps.

*Abdominal portion* of seven joints.

*Tail* composed of five lamina, the outer ones the broadest, oblong, serrate on their inner edge and ciliate, intermediate ones nearly linear, serrate and ciliated, middle lamina taper, acute, having a subulate appendage on each side towards its apex.

*Eyes* large and conspicuous from their dark blue centre.

*Antennæ* two pair, the inner and superior pair with three robust basil joints, and terminated by two long multi-articulate hairy setæ, the outer and inferior pair on a basis of but two joints, ending in a single seta, similar and nearly as long as those of the former; at their base, an elongated taper scale (particular form not determined) tufted at the extremity.

*Thoracic members* eight pair, long, filiform and ciliate within.

*Sub-abdominal members* five pair, each, of three articulations, the first clavate, and the terminal one ciliate—there are to be seen between the thoracic and abdominal members, some obscure processes in constant and rapid motion, these are no doubt the indications of the natatory division of the posterior thoracic members.

The motions of this animal were observed to be lively, and it gave out brilliant scintillations in the dark when disturbed. It was perfectly transparent, tinged here and there with orange-red, particularly its anterior feet, and showed the circulation most distinctly.

## *Genus 2.*

### *Cynthia.*

It may be objected, that this appellation has been already appropriated by Mons. Savigny to the most common and familiar type of the Ascidia, a name, which most Zoologists are more likely to retain, with every respect for that very eminent Naturalist; I therefore beg to apply it where it is more likely to remain undisturbed, and where it indicates the affinity which exists with the other luminous Genera of the Shizopodæ.

As I have just stated, the efforts made to procure females of the former Genus, led to the discovery of the present type, which bears a considerable resemblance both to Mysis



and to Nocticula, and in structure coincides to such a degree with the former, that many, of what are very improperly termed rigid Linnæans, would be disposed to consider them merely in the light of different species; no Naturalist however who understands any thing of the Crustacea, will refuse his assent to their being generically distinct, (not withstanding that we have only a *male* individual to contemplate) when the very peculiar structure of its sub-abdominal fins is considered; these in Mysis consist of a *single* joint, in Nocticula of *three* joints, while in Cynthia they are intermediate, and composed of but *two*; it is not in the *number* of joints alone, however, that they differ, their form and structure is also essentially different. In Cynthia, the four last of these members are each composed of a very large bilobate scale, supporting at its apex, two taper articulate fins, strongly ciliated with plumose setæ; from between these, originates an opaque organ, which bifurcates, its two extremes of unequal length, being rolled inwards the one over the other; the first pair differ in having but one perfect terminal fin, with the rudiment of the second and of the intermediate organ.

In what part of the Atlantic the specimen of this animal was procured has not been ascertained, but may be stated in a general way, as somewhere in the usual track pursued by West-Indiamen between Madeira and Barbadoes; neither is it known whether luminous or not, although presumed to be of the former description, this circumstance therefore remains to be determined, as well as the difference of structure in the female, and the mode of carrying her eggs.

The only other difference which declares it to be generically distinct from Mysis, we find in the inner division of the six posterior feet, which in place of the pluri-articulate termination, have this part obscurely divided into two or three joints only.

*Description of Cynthia.*

*Corselet* as in the Shrimps, slightly pointed in front.

*Abdominal portion* of seven joints.

*Tail* of five scales; outer ones oblong, obliquely truncated, truncation and inner edge serrate and ciliate, with a strong spine at the outer angle; intermediate scales taper, serrated, ciliated on their outer edge, inner edge with alternate long and short spines; middle scale slightly taper, truncated at the end or very slightly indented, serrate and spinous on its outer edges, the spines lengthened towards its end where they appear almost clustered.

*Eyes* remarkably large.

*Antennæ* two pair; the inner antennæ of three remarkably robust basil joints, surmounted each by a pair of pluri-articulate setæ of which the outermost are the longest, at the inside of the last basil joint is a taper sessile appendage very strongly ciliated and analogous to the brush of the male Mysis; inner antennæ of two basil joints ending in a shorter pluri-articulate seta, slightly hairy, the scale at its base, oblong, obliquely truncated, with a short spine at the outer angle of the truncation, and serrated and ciliated along its inner edge.

*Thoracic members* eight pairs, divided to the Coxæ into two parts; the outer divisions being pluri-articulate, and feathered towards their extreme, and bearing the Branchia at their base; the inner divisions, independent of a basis resembling the branchia of the outer ones, are composed of about five joints, which in the six posterior, bear a strong terminal curved claw, the two anterior resembling considerably the same members in the genus Mysis.

*Mouth*, not dissected; the Palpi in their two last joints appear to approximate to the same organs in Mysis.

*Sub-abdominal fins*, already sufficiently described.

The appendage to the Male organs in situation and structure shews also an approximation to the same part in Mysis, and ends in three curved hooks.

*Genus 3.**Lucifer, Long-headed Shrimp.*

THIS singular and extraordinary type of the Shizopodæ, like Nocticula, conduces to the sparkling appearance of the sea in the Tropical regions, the individual figured in the plate having been taken in the Atlantic September 15th N. Lat. 11° 56' W. Long. 32° 55'

We perceive in this animal a form hitherto unknown amongst the Crustacea, viz. linear or vermiform, the corselet not being broader than the abdominal segments, with its anterior portion lengthened out into a kind of neck widening in a slight degree upwards, and bearing at its extremity, the Eyes and Antennæ with their appendages, while the mouth is situated at a great distance under the breast.

It shews no further relationship to the former Genera, than in possessing, long, simple, ciliated thoracic members, these seem however to be fewer in number, and although the natatory divisions characteristic of the Shizopodæ were not observed, for the same reason as mentioned under Nocticula, I have no doubt of their existence: the thorough developement of the abdominal portion of the animal, of the sub-abdominal fins and tail, discountenance the idea of its being the larva of some known Crustaceous Genus.

The whole of the animal is colourless and transparent, with the exception of its intestinal canal, which from the opacity of its contents could be traced from the thorax to the tail.

*Description of Lucifer.*

*Corselet*, linear, posteriorly compressed, anterior portion lengthened out and truncated, with a short spine at the outer angles.

*Abdominal portion*, of six linear segments, the last largest with two short aculei on each side.

*Tail* of five scales; the outer ones oblong, obtuse, and ciliated; the intermediate scales taper, rather acute and ciliate; middle scale subulate and somewhat shorter than the rest.



*Eyes* extremely large, placed at the end of long spreading footstalks.

*Antennæ*, two pair; inner pair, linear, longer than the eyes, each composed of a long basil joint and three shorter joints, surmounted by a few short hairs; outer pair (probably broken in the specimen) composed of two long and one short intermediate joint, rather longer than the inner antennæ. Scales narrow, taper, and ciliate, as long as the first joint of the outer antennæ.

*Thoracic members* five or six? pair, long, setaceous and hairy; the anterior pair, short and bent downwards, were continually in motion, and may probably prove to be its Palpi, as the mouth appears to be situated between them.

*Sub-abdominal fins*, of which there is a pair to each of the five anterior segments of the abdomen, are composed of a basil joint, supporting two taper ciliated fins, with the exception of the first, which as in *Cynthia*, supports but a single fin.

#### *Genus 4.*

##### *Podopsis, Hammer-headed Shrimp.*

THIS Genus remarkable for the great length of the Footstalks on which its large and spreading Eyes are placed, like the former, was discovered in that region of the Atlantic frequented by the *Nocticula*, being captured in N. Lat. 29° 30', W. Long. 32° 55', on the 25th September, where it contributes its share to the luminosity of the sea. Like the former Genera also it is perfectly diaphanous and colourless, and although its members were not particularly scrutinized, is undoubtedly a natatory Shizopoda.

##### *Description of Podopsis.*

*Body* in general configuration similar to that of the Shrimp, but of a more slender and taper form, with the Eyes spread out horizontally.

*Corselet*, somewhat taper, truncate or slightly emarginate anteriorly.

*Abdominal portion* taper, of six segments, the last long and very slender.

*Tail* of five scales; the outer ones broad at the base, acuminate and ciliated; intermediate scales taper and ciliate; middle scale very short and pointed.

*Eyes* very large, on extremely long, slender, divaricate footstalks.

*Antennæ*; near to the insertion of the footstalks of the Eyes, are two short appendages which are probably the rudiments of the upper antennæ; the lower pair of antennæ are as long as the corselet, filiform, composed of four joints tipped with hair, Scales equal in length to the antennæ, taper and ciliated on their inner edge.

*Thoracic members*; one pair *unique*, nearly twice the length of the corselet, of five joints, the last hairy within; the rest of the members appear to be composed of three or four joints, and hirsute.

*Sub-abdominal fins*, five pair, each, of two or three joints, the terminal joints ciliated, and doubled in the two last pair.

#### *General Remarks on the Shizopodæ.*

Having completed the description of all the cleft-footed Crustacea decidedly belonging to this Order, as well as of such as from their structure are presumed to be referable to it, and which if they do not find place here, cannot be associated with any other known group, it may be advantageous to review the characters which are peculiar to these animals, and which appear to distinguish them from the Decapodous Macroura, (Shrimps, &c.) which they most resemble. In all the well defined genera of the Shizopodæ viz. Mysis, Nocticula, and Cynthia, we have found a greater number of locomotive members or feet viz. *eight* pair, divided to the Coxæ (hip) into two branches, of which

the outer are exclusively adapted to swimming and carry the branchia or gills around their basil joint, so that they present us with *perfect* animals possessed of *four rows of feet!* the inner rows, which are appropriated to the same purposes as the usual members in the true shrimps, are besides wholly unfurnished with chelæ or claspers. Our present ignorance of the habitudes of these animals, will not permit our deriving any benefit from characters taken from their mode of breeding, but as in *Mysis*, it is probable that they do not undergo any metamorphosis.

The animals with which they are most likely to be confounded, however, are the larvæ of the Decapoda, which are *temporarily* Shizopodæ, but may generally be distinguished by the division of the limb originating from the extremity of the femur or thigh, and shewing no appearance of external branchia ; besides, they are comparatively small and *imperfect* animals, in which the sub-abdominal fins and tail are never completely developed. From a consideration of these characters, the author is induced to exclude *Nebalia* from the true Shizopodæ, which as before hinted, is probably the larva of some crustaceous animal ; at all events, its characters have not hitherto been sufficiently developed by the few Naturalists who have become acquainted with it, to enable us to pronounce as to its true situation or affinity.

No doubt the Shizopodæ will receive considerable accessions both of genera and species, when more attention is given to the less conspicuous of the marine Crustacea, for as we have seen, the largest of them scarcely exceed an inch in length, and they appear to be widely distributed, existing from the Equator to the confines of the North Pole, as well in the briny ocean, as in the brackish water of rivers and estuaries.





*On the Metamorphoses of the Crustacea.*

IN Plate VIII. fig. 1, is given a representation of the Zoe or Larva of the common or edible Crab, (*Cancer pagurus*,) alluded to page 9, and which should have accompanied the Memoir it was intended to illustrate, had not the plates been previously filled. Immediately beneath the magnified figure, the animal is given of its natural size : on comparing these figures with those in Plate II, we shall gain a tolerable idea of the disparity in size, between a Zoe newly hatched and one which has attained its full development, and of the changes which the various parts undergo during the growth of the animal ; it must not be taken for granted, nevertheless, that these are the Zoe of the same species of Crab, for although the Zoes of different genera resemble in the main, they yet appear to present variations which may enable an acute observer to pronounce as to the species, when we become more familiar with these curious animals : the most obvious and remarkable difference which the present figure exhibits, is the total absence of the sub-abdominal fins, and the natatory division of the two pair of feet, being provided with only *four* terminal plumose setæ. Zoes of this latter kind or in their younger stages, are very numerous in the harbour of Cove during Spring, while those of full growth are of comparatively rare occurrence, so that it is probable that multitudes of them fall a prey to the other inhabitants of the deep, neither their grotesque figure, nor the extraordinary length of their spines, affording a sufficient protection against many of their enemies.

Subsequent to the discovery announced in the first Memoir, p. 8, viz. that Zoe in undergoing a metamorphosis, appeared to pass into some form of the Decapoda, the author became desirous of ascertaining whether it might not be possible to hatch the ova of some of these animals, so as to afford a satisfactory confirmation of so novel and

unlooked for a fact, and after numerous fruitless attempts year after year, he at length procured, in 1827, examples of the common Crab with spawn apparently ready to hatch, and by means of the kind assistance of Mr. Kingdom, Naval Storekeeper at Hawlboline, succeeded in protecting one individual until the young burst from their envelopes and swam about in myriads, under the exact form given in the plate; in this stage, they are colourless and transparent as glass, except the dark central part of each eye, and a blackish dot on each side every abdominal segment, the dorsal spine exhibiting a pale pink tint for nearly half its length from the point downwards.

Some gentlemen having expressed doubts as to the *universality* of the metamorphosis in the Decapoda, let it be remembered, that the contrary opinion hitherto held, is merely an assumption, and that the metamorphosis having been proved in a *single* instance, amongst animals so uniform in structure as the Homobranchia, we may safely infer from analogy, as far as regards the particular tribe alluded to, that it is general; we have seen that in the common Crab, (*Cancer pagurus*) the young is a Zoc, an animal so totally different in its aspect, structure, and habitudes, that it is evident, a very remarkable metamorphosis must take place before it can assume the form so familiarly known of the parent animal; when this fact is coupled with the circumstance, of no less than *six* other Zoes having been figured, (see Pl. I.) which from their localities and difference in form, most probably belong to as many genera of the Decapoda, it can hardly be said that the universality of the change wants confirmation. Besides, since the former Memoir was penned, the Author has had a confirmation of it in one of the West Indian land-crabs, and in some other of our most widely separated native genera, authorizing what he has advanced at p. 2, viz. "that the greater number of the Crustacea do actually undergo transformations, of which, in addition to



the facts now adduced, further instances will be given in future Memoirs."

In the first Memoir also, when speaking of the satisfactory explanation which this discovery gives of the annual visits of the Land-Crabs to the sea, in order to deposit their spawn in that element, he appears to have been misunderstood, for hitherto the rationale of this long and dangerous journey did not appear. Naturalists have thought it strange and inexplicable, that an animal decidedly and wholly terrestrial, should not spawn in its native haunts, and rear its young at home, instead of putting them to the trouble and risk of a tedious and unknown route back again in their very tender age. There could scarcely be a stronger confirmation than this very circumstance of the universality of metamorphosis, for if there were any exceptions, it would certainly be made in favour of the terrestrial species, but no, they are, when first hatched, incapable of living out of water, with members solely adapted to swimming, hence the parent is impelled by its instinct to seek that element for its progeny, which nature has designed for the whole of the tribe to which they belong. Having been many years amongst the West India Islands, with the facts connected with the land-crabs constantly before me, I could never invent any plausible excuse for this curious piece of economy, nor indeed any one else, which should teach us to regard with complaisance the deviations and eccentricities which we observe in Nature, and which have all, no doubt, some specific object in view, although difficult or impossible for us to discover.

I avail myself of this opportunity to correct an error in the Explanation of the Plates to the Memoir on Zoea, p. 33, where in Plate II. fig. 8, the *two* antennæ from the *same* side are figured, *a.* being the inner, and *b.* the outer antenna.

*On Mysis.*

AT page 16 of the second Memoir where the gradual developement of the embryo of the Opossum Shrimp is stated, it must be clearly understood that it is not the egg of which the Author speaks, but the *embryo* divested of the tunics which envelope the *ovum* on its first exclusion; in the other animals of the Crustacea in which an analogous *structure* to that of the pouch is observable, viz. the aquatic Isopodæ, it serves merely as a protection to the *ova*, which hatch all at once, the young as far as we know, coming out quite perfect, as we see in most oviparous animals.

## ERRATA.

- Page 39, line 5.... *for medusa read medusæ.*  
41, " 31.... *for Godcheu read Godeheu.*  
50, " 12.... *for of read or.*

## NOCTICULA.

PLATE V. Fig. 1. *a*, *Nocticula Banksii* of its natural size. Fig. 1. *b*, magnified; 1 *f*, feet; 2 *f*, supposed male organs; 3 *f*, sub-abdominal fins; *e*, eye; *a* 1, inner pair of antennæ; *a* 2, outer pair of antennæ; *s*, anterior scales. Fig. 1. *c*, Tail more magnified.

Fig. 2. Luminous Shrimp, after the figure in the Philos. Transactions.

## CYNTHIA.

PLATE VI. Fig. 1 *a*, *Cynthia* magnified. Fig. 1 *b*, its natural size.

Fig. 2. Anterior parts of the same more magnified; *c*, corselet; *e*, eye; 1 *a*, superior antennæ; *b*, analogue of the brush in the male *Mysis*; 2 *a*, lower antennæ; *s*, anterior scales.

Fig. 3. Tail of the same still more highly magnified.

Fig. 4, *a*, *b*, the two extreme joints of one of the Palpi.

Fig. 5. One of the inferior antennæ; *a*, its pluri-articulate seta; *s*, its ciliated scale.

Fig. 6. Inner branch of the anterior thoracic member.

Fig. 7. Second Member; *a*, inner division; *b*, outer natatory division; *g*, branchia; *x*, point of attachment to the animal.

Fig. 8. One of the six posterior members; *a*, inner division; *b*, natatory division; *g*, branchia; *x*, point of attachment.

Fig. 9. *a*, One of the second pair of the sub-abdominal fins; *x*, point of attachment; the third, fourth, and fifth are similar.

Fig. 9. *b*, One of the first pair of the sub-abdominal fins.

Fig. 10. One of the scales situated between the hindermost pair of thoracic members.

## LUCIFER AND PODOPSIS.

PLATE VII. Fig. 1. *Podopsis*, magnified, and of its natural size; 3 *f*, sub-abdominal fins; *a* 2, anterior members; *p*, probably palpi; *a*, supposed rudiments of the superior antennæ; *a* 1, inferior antennæ; *s*, ciliated scale; *e*, eye.

Fig. 2. *Lucifer* magnified, and of its natural size; 1 *c*, anterior part of the corselet; 2 *c*, posterior part of the corselet; *f* 1, ciliated members; *f* 3, sub-abdominal fins; *a* 1, superior antennæ; *a* 2, inferior antennæ; *s*, ciliated scales; *e*, eye; *t*, tail.

PLATE VIII. Fig. 1. The Zœa of the common crab, (*Cancer pagurus*,) magnified. Near the letter *f* it is represented of its natural size; *a*, antennæ; *f*, feet; *s*, one of the lateral spines.

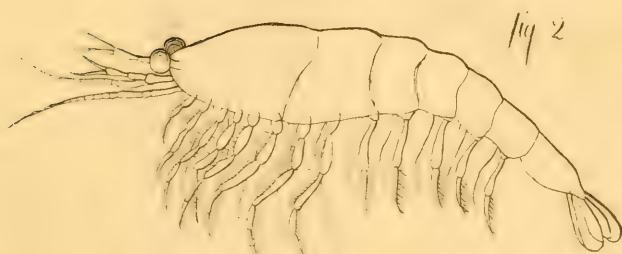
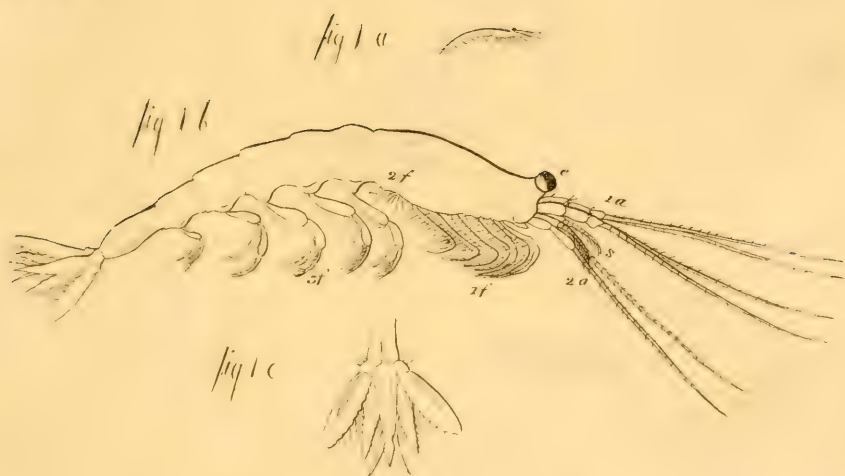
Fig. 2. *Sapphirina*; *a*, natural size; *b*, magnified, from above; *c*, magnified, from beneath; *x*, trifid anterior members.

Fig. 3. *Pyrosoma pygmæa*.





PL. V.



NOCTICULA.  
*97 1/2 feet*

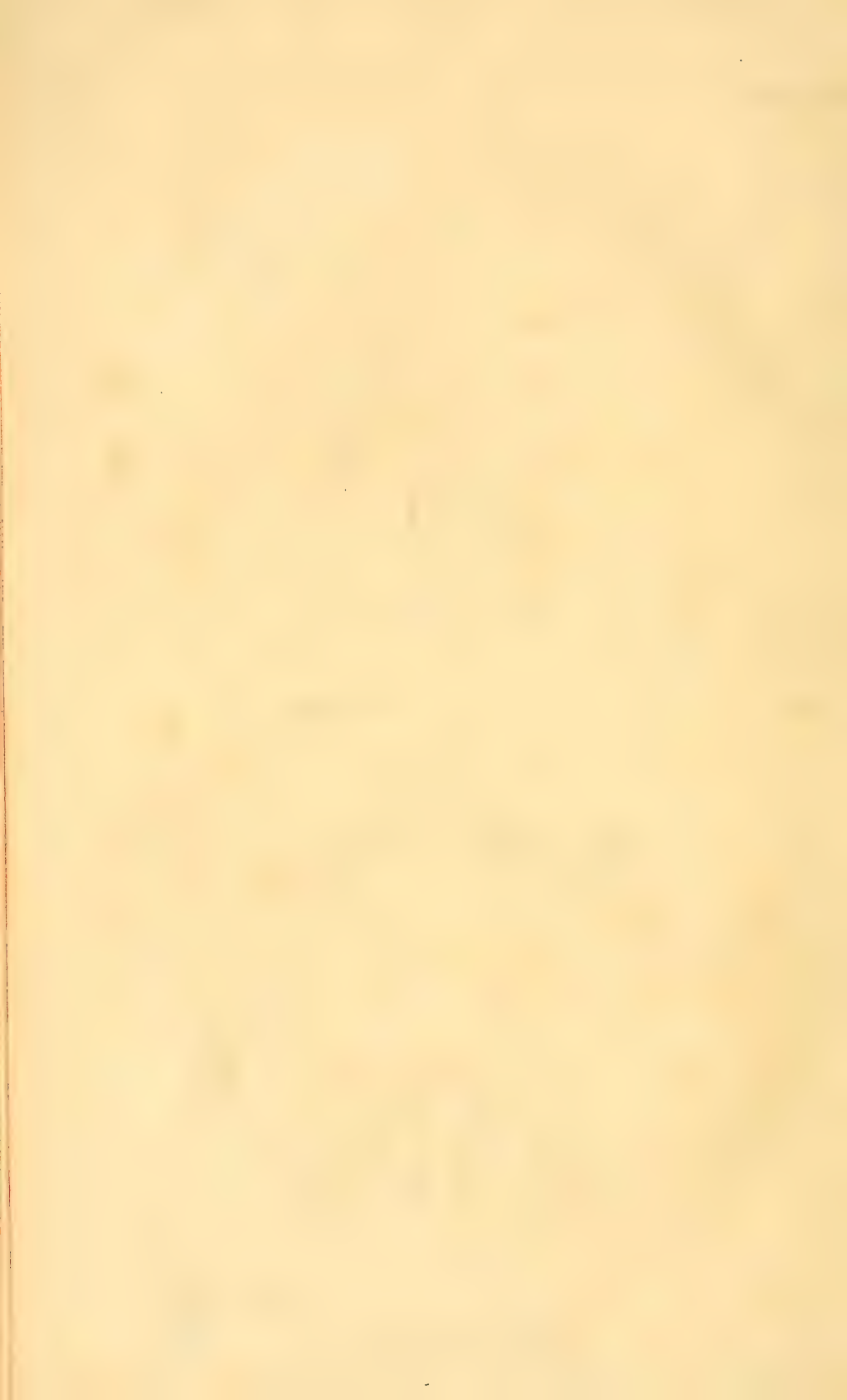






CYNTHIA.

INT. del. et sculp.





LUCIFER,

PODOPsis,

*L. V. Hyal*









## ZOOLOGICAL RESEARCHES.

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### MEMOIR IV.

*On the Cirripedes or Barnacles ; demonstrating their deceptive character ; the extraordinary Metamorphosis they undergo, and the Class of Animals to which they indisputably belong.*

NATURALISTS of the greatest leisure, and the most devoted to their favorite pursuit, as well as those to whom the most opportune occasions present, have seldom to congratulate themselves on any other discovery than that of a few *new* Genera or Species, rarely on that of a type difficult to associate with those already known, or of a fact altogether new and without parallel; how highly then ought we to estimate that of the *Metamorphoses of the Crustacea*, announced in the First of these Memoirs, and those facts now about to be exposed in regard to the Cirripedes, a tribe of marine animals which have long puzzled the most acute and laborious Zoologists. Although both of these Memoirs, from the nature of the discoveries made, have a tendency to condense, rather than to extend and amplify our distributions of animals, I nevertheless consider myself as having been highly favored, and feel it incumbent upon me to give them publicity with all the detail of which they admit.

The animals embraced under the title of Cirripedes by Naturalists, are familiarly known in these countries by the name of Barnacles. Two very different types are included under this comprehensive name, viz. the families of Lepas or true Barnacles, (shewn in the wood cut) and that of



the Balani or the acorn-shells of British Conchologists (Pl. IX. f. 11, 12.); the former elevated on a membranous pedicle, the latter sessile and provided with a domicile wholly calcareous; both are marine, and several species of either, amongst the most abundant and common productions, the Balani attaching themselves for the most part to the surface of rocks, stones and other *fixed* bodies, and are consequently littoral, the Lepades on the contrary are rarely found on *fixed* bodies, but almost always on such as float upon the surface of the open ocean, as Fuci, pieces of wood, and the bottoms of ships, by which means they participate in the benefits of the vagrant life of those Crustacea which are gifted with perpetual freedom of motion. In this distribution of the Cirripedes throughout the ocean, we recognize the operations of Superior Intelligence, as well as in the peculiar structure of these curious and interesting animals, which fits them so admirably to



draw within the vortex created by their cirri the minute and powerless animalculi with which the surrounding element abounds. In order to account for the election made by those two types of the Cirripedes as to site, it might be supposed that the *ova* were of different specific gravity, that those of the Balani from their greater density were disposed to remain at or sink to the bottom, while those of the Lepades being lighter tended to rise towards the surface, and by a glutinous property attached themselves to the first solid body with which they came in contact ; there will be no further occasion for the exercise of our ingenuity however to account for this remarkable circumstance, when aware that *in the first state of these animals they not only possess perfect freedom and power of motion, but organs of sight* which furnish them with the means of making that election which is best suited to their respective habits as impressed upon them by Omnipotence, and members calculated to anchor them securely to the chosen spot ! how otherwise should we find the Coronula and Tubicinella exclusively on the backs of the Whale tribe, the Chenolobia on the shells of Turtle, and Acasta as invariably imbedded in Sponge ?

That these animals should have been a great stumbling block to systematists is not much to be wondered at, considering the complete disguise under which they usually present themselves, and our total ignorance of that part of their Natural History about to be developed. The celebrated Linnæus arranged them under the sole generic title of *Lepas*, with the Testaceous *Mollusca*, (Shells.) Naturalists of the present day, anxious to group them from their Natural affinities, deduced principally from anatomical structure, have scarcely been more happy in assigning to these animals a more suitable station. M. Cuvier, for example, arranges them with the Mollusca, of which they constitute his sixth or last class, by which means they are interposed between the above named race and the Annelides

and widely separated from their real relations the Crustacea. "Behold us" says he "arrived at animals very different from all the *Mollusca* of which we have hitherto spoken:—members of a horny texture, in some measure articulated, numerous, susceptible of varied movements, a mouth furnished with lips and jaws, a nervous system formed of a series of ganglions, announce that Nature is about to conduct us to the race of articulated animals"—"Nevertheless as their body is not itself articulated, as we have already in the Terebintines, which undoubtedly belong to the acephalous *Mollusca*, examples of articulated members, as in short the shell of the Lepades seems to be modelled after that of many Bivalves, we think ourselves authorized to leave this Order amongst the *Mollusca*." *Mem. sur les animaux des Anatifes et des Balanes*, &c. p. 1. Cuvier follows up the comparison of the five valves in *Lepas anatifera* with those of the *Muscle* p. 3 and at page 6 makes what must now be considered a more just comparison between these animals and the Crustacea. Mons. Lamarck also, has the Cirripedes as a distinct Class, which with Cuvier he places between the *Mollusca* and the *Annelides*. Latreille in his last work "*Familles du Regne Animal*" assigns them as a Class the same situation, but appears still to consider them as *related* to the Ostracoda and Branchiopoda of the Crustacea; that he has not been able to form any decided opinion is evident however from what he says p. 231 "The sessile Cirripedes would appear to represent in this place the animals which terminate the family of the *Acéphales enfermés* of M. Cuvier. The two tubular horns of the Otions (*Lepas aurita* Linn.) present to us, (but with other uses) the two tubes of many *Acéphala*! the tentacula of these last animals are converted into jaws. The cirri are a kind of feet divided into branches, and analogous to the sub-abdominal appendages of many Crustacea, and especially the Amphipoda; we may also compare them to those of many *Annelides*.

The oviduct has some resemblance to that of the Phalangiums. It is thought in short, that Nature to form the Cirripedes, has borrowed *different sorts of organs from the animals of several Classes.*"

The Zoologists of our own country who have devoted a share of their attention to these animals, have also considered the Cirripedes as constituting a distinct Class. Mr Leay in his *Horæ Entomologicae*, thinks, and not without reason, that the Lepades (Pentelasmus) shew the greatest affinity with the Ostracoda (Daphnia) of the Crustacea (p. 307) but what appears extraordinary he seems to imagine that the Balani belong to a *different Class* (p. 309) and that there exists an affinity between the shell of these and that of the Echini or Sea-eggs (p. 313), and sanctions the opinion of Latreille that their articulated cirri have their analogue in the *arms* of other genera of the Radiata, and particularly Comatula! (p. 315).

These quotations while they clearly shew the distraction which these animals have caused to the most intelligent observers, make manifest the high importance we should attach to the discovery of their real nature, the key of which has hitherto remained concealed in their Metamorphosis, without a knowledge of which they must have remained as an enigma incapable of any satisfactory solution.

From the heading of this Memoir, some readers aware of all that has been already written on the subject of these animals, might suspect a revival of the old and vulgar fable of their being the young or embryo state of the wild-geese which teem over the northern regions of Europe and America; and although this would be a prodigy quite incompatible with the laws of Nature, as Dr. Tancred Robinson has long ago shown, (*Philos. Trans. abridged*, Vol. 2 p. 850.) we shall find the Cirripedes, as I have before stated, really to undergo a metamorphosis scarcely less wonderful, and hitherto without parallel in the whole range of nature, and one which clearly shews that *Classical characters*,



derived from the circumstance of animals being fixed or free ! furnished with eyes or destitute of sight ! are not always of that importance which Naturalists are disposed to attach to them, and of which additional proofs will be found in the future pages of these Memoirs.

The belief that the Barnacles are the young or embryo state of the Barnacle Goose ( *Anas erythropus* Linn. ) and the Scoter or Black Goose ( *Anas nigra* Linn. ) is one of those popular errors which has not only extended through several ages, but still prevails amongst the vulgar on all the shores of the European seas, and appears to have no other foundation than a fancied resemblance in the plumose members of the animal-inhabitant to the wing of a bird. One circumstance however which serves in no small degree to keep up this absurd error, and may be worthy of remark, is that in some Catholic countries, the above species of Geese are still considered as of the Finny tribe, in order to extend the bill of fare at Lent and at other times of fasting and abstinence “ *C'est un gibier d'eau fort estimé ; une qualité, que les pieux gourmet savent apprécier, c'est qu'on peut le manger dans le temps d'abstinence religieuse* ” ( *Article Benache, Nouv. Dict. d'Hist. Nat.* ) “ The bird which at Paris is called Macreuse, and in the other parts of France Macroul, the French eat upon fast days and all lent, thinking it to be a sort of Fish, or a marine animal with cold blood, or else a Barnacle generated either out of rotten or corrupted wood floating upon the sea ; or out of certain fruits falling into the water, and there metamorphosed into a Bird, or else from a kind of sea-shells adhering to old planks and ships' bottoms called Conchæ Anatiferæ ( *Lepades* ) ” Dr. Tancred Robinson ( *Philos. Trans. abridged*, — Vol. 2, p. 850.

To show how far the force of imagination will sometimes carry men who from station and education should be fortified against such delusion, I need only add what Sir Robt. Moray has said upon this subject in a grave communication



which is to be found in the same work p. 849-50, No. 84. Having observed wood thrown up by the ocean on the shores of the Western Isles of Scotland which were covered with Barnacles, (from the figure and description probably *Lepas anatifera*) he states that the pedicle "seems to draw and convey the matter which serves for the growth and vegetation of the shell and the little Bird within it." "In every shell that I opened I found a perfect *Sea-Fowl*; the little bill like that of a *Goose*, the eyes marked, the head, neck, breast, wings, tail and feet formed, the feathers every where perfectly shaped, and blackish coloured, and the *feet* like those of other Water-Fowl to my best remembrance"—"nor did I ever see any of the little Birds alive, nor met with any body that did; only some credible persons have assured me that they have seen some as big as their fist!!

The facts about to be laid open in regard to the Cirripedes are of so extraordinary and novel a nature, that they would hardly gain credence did they not proceed from some respectable source, or were they not placed within the power of every Naturalist to satisfy himself of their correctness without any remarkable degree of trouble. They were partly, like many other interesting discoveries, the result of chance rather than of design and industry, and were at the same time accompanied by so many interesting circumstances as to render memorable the day on which they first presented themselves to the notice of the author. On that day April 28, 1823, devoted to the investigation of some marine productions, he was returning home without any addition to the stock of knowledge, when casually throwing out a small muslin towing net on crossing the Ferry at Passage, such a capture of minute animals was made as furnished a treat which few can ever expect to meet, and could hardly be excelled for the variety, rarity, and interesting nature of the animals taken. Some of them never before met with but in the great Ocean (*Zoe Taurus*);

others previously seen by a solitary observer (*Argulus armiger*) and almost lost sight of by Naturalists and excluded from their works; others actually inhabitants of fresh water and quite accidental (*Polyphemus oculus*); some not commonly observed (*Megalopæ*); others perfectly nondescript and incapable of being associated in any of our classifications of the Crustacea; of this description is the little animal about to be described: besides these were many others of inferior note, as *Cyclops*, *Praniza*, *exuvia* of *Tritones*, &c.

Without dwelling upon the advantages of such an unexpected and valuable accession to a person in pursuit of the Natural History of Marine animals, the above nondescript and anomalous genus, as it was thought at the time, shall be first described, and then the facts which the last season has furnished towards the completion of its history.

This is a small translucent animal one tenth of an inch long, of a somewhat elliptic form, but very slightly compressed laterally, and of a brownish tint. When in a state of perfect repose it resembles a very minute muscle and lies upon one of its sides at the bottom of the vessel of sea water in which it is placed; at this time all the members of the animal are withdrawn within the shell, which appears to be composed of two valves united by a hinge along the upper part of the back and capable of opening from one end to the other along the front, to give occasional exit to the limbs. The limbs are of two descriptions, viz. anteriorly a large and very strong pair, provided with a cup-like sucker and hooks, serving solely to attach the animal to rocks, stones, &c. and posteriorly six pair of natatory members, so articulated as to act in concert and to give a very forcible stroke to the water, so as to cause the animal when swimming, to advance by a succession of bounds, after the same manner as the water-flea (*Daphnia*) and other *Mono-culi*, but particularly *Cyclops* whose swimming feet, are

extremely analogous : for a more detailed description of these members consult the explanation of Plate IX. The tail which is usually bent up under the belly is extremely short, composed of two joints, and terminates in four setæ, and is employed to assist in progression and in changing the position from a state of repose. The greatest peculiarity however in the structure of this animal is the eyes, which although constantly shielded by the valves of the shell, are pedunculated ! as in the Crab and Lobster, and placed anteriorly at the sides of the body.

Any Naturalist acquainted with the Crustacea, on reading this short description will readily assent to what has been advanced as to the very extraordinary and anomalous character of this little animal, and to the dislocations it seems calculated to produce in our Classifications : but for its pair of pedunculated Eyes it would find place as a new Genus of the bivalve Monoculi (Ostracoda) ; its members approximate it to Argulus on the one hand and to Cyclops on the other, Genera which are widely separated ; while its Eyes shew its relationship to the Decapoda (*Crabs, Lobsters &c.*) ; reflecting upon all these circumstances, and others viz. their great abundance during the early part of spring alone, and their presenting no variation indicative of a difference of sex, induced a belief that they were the larva or disguised state of some Crustaceous animal, or (as it had been previously ascertained that the Cirripedes were Crustacea) that they were the *males* of these, not being disposed to believe that the two sexes were united in the same individual ; in favour of this idea too, it may be observed that the males of many Crustacea are remarkably less in size and different in aspect, as in the Caligi and Bopyri, and also that in some they are rarely met with, and only at a particular season, one impregnation serving for all the broods thrown off in the course of the animal's life, as in Daphnia ; to which may be added that all the Barnacles examined by comparative anatomists, have proved to be of the female sex or were at least furnished with ovaria.



Under the foregoing impressions, some of them were collected in the Spring of 1826. and in order to see what changes they might undergo, were kept in a glass vessel covered by such a depth of sea-water that they could be examined at any time by means of a common magnifying glass; they were taken May 1st, and on the night of the 8th, the author had the satisfaction to find that two of them had thrown off their exuvia, and wonderful to say, were firmly adhering to the bottom of the vessel and changed into young Barnacles! such as are usually seen intermixed with grown specimens on rocks and stones at this season of the year—(*Balanus pusillus* Penn.) In this stage the sutures between the valves of the shell and of the operculum were visible, and the movements of the arms of the animal within, although these last were not yet completely developed; the Eyes also were still perceptible, although the principal part of the black colouring matter appeared to have been thrown off with the exuvium. On the 10th another individual was seen *in the act of throwing off its shell*, and attaching itself as the others, to the bottom of the glass. It only remains to add that as the secretion of calcareous matter goes on in the compartments destined for the valves of the shelly covering, the Eyes gradually disappear, from the increasing opacity thence produced, and the visual ray is extinguished for the remainder of the animal's life; the arms at the same time acquire their usual ciliated appearance.

Thus then an animal originally natatory and locomotive, and provided with a distinct organ of sight, becomes permanently and immoveably fixed, and its optic apparatus obliterated! and furnishes not only a new and important physiological fact, but is the only instance in nature of so extraordinary a metamorphosis.

Having made manifest the metamorphosis in the Cirripedes, and shown by the nature of the animal in its first or larva state, that they are clearly referable to the class of Crustacea, it may still be thought requisite to add the



other proofs that they are so ; these are derived from the structure of the mouth (pl. X. fig. 4. 5. 6.) and from the fact of their throwing off their exuvia exactly after the manner of the other members of this class, a circumstance hitherto denied, but of which any person may be easily satisfied. During the whole of the spring and summer months, the water teems with these exuvia of Tritones, (the animal-inhabitant, according to Linnæus, of the Barnacles)—it is impossible to avoid drawing up numbers every time a towing net is thrown out, nay the tide is at times discoloured from their abundance ; but to be certain that these are really such, let a stone with several barnacles upon it, be kept in sea water, regularly renewed, towards the latter end of April or the beginning of May, and with due attention many of them may be observed *in the act of throwing off exuvia* in every respect identical ; let it be recollected however, that these are casts of the *animal* alone, and not of the valves of the shell, or of the operculum. If these exuvia be examined with care, a considerable approach in the limbs and mouth to the more perfect Crustacea will *now* readily occur, the former are composed of six pair, in structure however, more resembling the limbs of Mysis than the Decapoda, being divided into two pluri-articulate branches from the second joint ; the mouth is furnished as in the above tribe with two pair of true jaws and with a *palpigerous* pair of mandibles, but is without the pedimaxillæ, thus also they approximate in the apparatus of the mouth to Mysis, and only differ in the greater simplicity of the parts, and in the Palp being composed of but two instead of three joints. A comparison may be readily made by a reference to the Plates of Triton and Mysis which mutually illustrate each other.

The circumstance of their undergoing a metamorphosis might have been urged against the Cirripedes being Crustacea, had not the author anticipated this objection by his discovery, that these latter, contrary to the received opinion

do actually undergo Metamorphoses ( see Memoir 1st. ) of which he has many new proofs to adduce.

Having stated the several points which shew the Cirripedes to be true Crustacea, and to be very closely related to the more perfect animals of that Class, I beg to suggest the probability of the Exuvia of the Balani, having led Linnæus and others into the opinion of the Animal of the Barnacles ( or Triton as he has named it ) living in a separate state in holes of rocks &c. an opinion which the foregoing discoveries must completely annul. The most naked and unprotected of the Barnacle tribe are the genera of Otion and Cineras, and these attach themselves to the *superficies* of floating bodies, while the only genus known to live *deeply imbedded* in rocks and stones viz. Lythotria, is provided with a solid calcareous basis, and above with eight equally solid valves. Cuvier appears to be the only Naturalist who had already declared himself of the same opinion:—"Linnæus supposing that Cirripedes are also found without any shell, gave them the name of Triton, but the existence of these Tritons in nature is not established as certain, and we should rather think that Linnæus had only seen the animal of some Barnacle (anatife) torn from its shell." *Regne Animal*, Note, Vol. II. p. 506.

From a consideration of the whole History of these animals are we to conclude that they have the *sexes united* ? a fact so much at variance with what we see in all the rest of the Crustacea may authorize a degree of scepticism, for although they are fixed for life when they put on their permanent disguise, yet from their associated or clustered mode of growth, and from the extreme length of the tubular organ which terminates the body above, they may still appear capable of communicating with each other : dissection however favors the former idea, for the oviduct of each side, formed by the union of branching tubes from the various lobes of the ovary, becomes suddenly bulky, gland-like and tortuous, and has been thought to represent the male organ,

and to impregnate the ova in their passage through it ! having preserved the same appearance as it mounts along the side of the body, it again, at the height of the anus, as suddenly becomes a simple canal or tube, unites with its fellow from the opposite side in the ovipositor or that long proboscidiiform organ in which the tail part or highest end of the animal ends, at the extremity of which they open together by a simple orifice.

Those who may wish for further particulars of the anatomical structure of the Cirripedes are referred to the unrivalled work of Poli "*Testacea utriusque Siciliæ*", to a memoir by Cuvier "*Sur les animaux des Anatifes et des Balanes*" and to the Lectures on Comparative Anatomy of Sir Everard Home.

Towards the completion of the Natural History of this tribe of animals; it remains to be known whether the Larvæ of all the Genera are similar or dissimilar, and whether, in any of them, males exist at any stage of their progress. Industry and the acuteness of the present generation may be expected to bring about the solution of these interesting questions in the course of a very few seasons, now that the road has been so fully pointed out.

In the thirteenth Lecture of Sir Everard Home on the comparative anatomy of Animals, Vol. III p. 410, that gentleman exposes the economy of the *Lepas anatifera* in regard to its propagation, and which might incline some Naturalists, sensible of the authority due to so celebrated a veteran in the paths of science, either to doubt the wonderful facts now brought forward, or to imagine that the mode of propagation may be very different in the *Lepadæ*. Sir Everard finding the fleshy tubular pedicle replete with ova after their exclusion from the Ovaria in the specimens which he examined, supposes they remain there to receive their ultimate developement, but has probably been deceived in imagining the embryos to make their way out through the parietics of the pedicle, by which he accounts for their

associated mode of growth. How, if that is the case, are we to explain the detached mode of growth of many of the species ? how their growing from the outer surface of the solid valves ? and how they are communicated to new sites? analogy is too strong altogether to permit us to doubt that they do not resemble the Balani in this particular. No doubt the appearances exhibited pl. CL. coupled with the fact of the ova being found within the pedicle, are calculated to mislead, but we perceive the associated species of Lepas attaching themselves indiscriminately to the valves, the pedicle or its basis, as well as to all sorts of floating bodies.



## ADDENDUM ON NEBALIA.

HAVING twice alluded to Nebalia in the previous Memoirs, from its supposed relation to the animals which have hitherto occupied our attention, and from its being a type almost unknown to the greater part of Zoologists, and which it would be desirable to have thoroughly and perfectly scrutinized, the author has thought it advisable to re-produce the only good figures of the two described species, and to repeat what has been communicated as to the structure and habitudes of these anomalous Crustacea, in the hope that Naturalists who may reside on or visit the coasts where they are said to be found, may furnish more satisfactory details, or submit specimens to the examination of some competent micrographer.

The best informed Naturalists have associated Nebalia with the Shizopodæ from the circumstance of having their members cleft or divided into two branches, and their appearing to have a pair of pedunculated eyes; when, however, we are aware of all the anomalies which affect the limbs and visual organs in the Crustacea, we shall not be apt to attach much importance to characters derived from parts liable to such extraordinary deviations, when they are not at the same time accompanied by some approximation in the general form and structure to the rest of the animals of the group; this is by no means the case with Nebalia, which in every other respect is an animal sui-generis, but certainly bears a greater degree of affinity to the Larvæ of the Balani than to any other; its antennæ, no doubt, constitute one difference, while its eyes and tail are *exserted* beyond the boundary of the corselet, differences which we might be prepared to expect in the larvæ of the various genera of the Balani: indeed, since the discovery announced in the preceding Memoir, it is difficult to dismiss a suspicion that Nebalia may be the Larva of some one of those types, and in particular of

Coronula; the larvæ of this Genus must of necessity possess useful eyes and a more powerful and perfect natatory apparatus, in order to perceive and pursue the Cetaceous animals (Whales) upon which they finally fix themselves.

We must not, however, shut our eyes to the facts furnished by Otho Fabricius in regard to the breeding of Nebalia, which if not deceptive, completely annul any such idea, and show it to be a peculiar Genus, most nearly related to the larvæ of the Balani, to which it will thence bear the same relation, as Mysis to the Decapodous Macroura.

The first animal of the present type was discovered by Otho Fabricius, and published with a figure in his *Fauna Groëlandica* under the title of *Cancer bipes*, p.256 No.223 f. 2, which figure has been copied by Herbst in his *Work on Crabs, &c.* Pl. XXIV. f. 7. Montagu more lately detected on the South coast of Devon, the individual figured in the *Linnæan Transactions*, Vol. XI. t. 2, f. 5, and still more recently Dr. Leach, the founder of this genus, has furnished us with a third, to which he assigns as a habitation, the European Ocean, *Zool. Misc.* Vol. 1, p. 100, t. 44.

All these, Dr. Leach, Desmarests and some other Naturalists consider as identical, or of the same species, and as the former gentleman from his more intimate knowledge of the accuracy and discriminating powers of his friend Montagu, is of this opinion, it would be presumptuous, in us to dispute the propriety of this decision; Mons. Lamarck not swayed by this consideration, very properly considers the Nebalia of Fabricius and Leach different from that of Montagu, the differences however, are principally such as might be supposed to arise from the latter using magnifiers of higher power, and bringing to the examination a greater or less degree of skill and scientific knowledge, thus his figure has all its members and

tail fringed with hairs and the styles of the tail annulate.

To observe animals of this small size and concealed character by simple inspection will not exactly answer the purposes of Natural Science as at present pursued, we must scrutinize, analyse and dissect, in order to determine the number, use, and structure of the various members.

Dr. Leach being the founder of this Genus, the first Crustaceologist in Europe, and of the most scrupulous exactness, we must naturally attach the greatest importance to the figure and description of *Nebalia* which we have from his hands, bearing in mind that the parts of the mouth remain to be dissected and made known.

*Description of Nebalia.*

The Cephalo-thoracic *Clypeus*, inclosing the body of the animal is large, sub-compressed, and ovalish in its lateral contour.

The moveable *Rostrum* or beak, which is one of the most remarkable characters of *Nebalia*, is taper, carinated above, and vaulted beneath.

The *Eyes* are rather small, and situated at the sides of the beak; they are compound, placed on short footstalks and moveable.

The *Antennæ* which arise on each side from above the eyes, consist of a single pair, each ending in two pluri-articulate setæ.

The *Anterior pair of Feet* are long and simple, serving for prehension (and are probably armed with microscopic hooks?)

The *Posterior or Natatory feet* consist of five pair, having their ultimate divisions bifid and fringed.

The Abdominal portion is composed of four or five joints, and ends in a furcate tail, the two taper styles of which end in setæ.

The *Nebalia Herbstii* of Dr. Leach attains to the length



of three-fourths of an inch and is of a pale red or greenish colour (greyish Leach) with black eyes, and inhabits sandy shores about Greenland and particularly the mouths of rivers, but is rare. According to Dr. Leach, it is also found in the European Ocean. The female, Fabricius says, carries her ova all winter, which begin to develop themselves in April, the young appear in May, are extremely active, *adhere* to the mother which has then but little life. In swimming they turn on the back and use their hinder feet, and when they rest, *fix themselves by the anterior pair* !

The *Nebalia Montagu*, which Montagu describes under the title of *Monoculus rostratus*, was only half the size of the former species, viz. three-eighths of an inch, is of a pale yellow colour, with a darker longitudinal line along each side ; inhabits the south coast of Devon. The fore feet, he adds, are usually motionless and brought down under the body, and that the antennæ as well as the natatory feet are continually in movement, when the animal swims.

I beg to repeat that we know these little animals too imperfectly, and that they present a field for future observers, who may happen to be so fortunate as to meet with them. We must see them reversed, the organs of the mouth and members developed and magnified, which in an animal of such size cannot be considered as a very difficult task, when we contemplate what has been performed on many of the smaller *Monoculi* not one-third part so large as the smaller *Nebalia*. In addition, it would be desirable to know whether they are really *perfect* animals, or only larvæ, determinable by keeping some of the full grown ones in sea water frequently renewed, or by the actual discovery of females provided with ova.



CIRRIPEDES.

PLATE IX. Fig. 1, Natural size and appearance of the young of the Barnacle (*Lepas balanus*) when reposing on its side, with its limbs concealed and the valves closed.

Fig. 2. The same somewhat magnified as seen from above, to show the turgid appearance of the valves. *a*, an elbow of the anterior members of the animal. *t*, tail part.

Fig. 3. Side view of the same more highly magnified, with its limbs protruding from the anterior opening of the valves. *b*, one of the fore feet, its fellow being removed for the sake of clearness; this member is represented as when naturally exerted by the animal when it wishes to fix itself by means of the sucker *c*, and claw *d*, a fourth large basil joint remains concealed by the shell. *f*, its six pairs of natatory members behind, seen as ready to give a stroke to the water; *t*, the bifurcate extremity of the tail. *e*, one of its peduncled eyes as seen through the shell. *x* presumed nucleus of future attachment on the dorsum.

Fig. 4. One of the Eyes detached and more highly magnified.

Fig. 5. The bi-articulate tail, more highly magnified ending in two long and two shorter setæ *t*. *a*, posterior part of the abdomen.

Fig. 6. One of the posterior or natatory members very highly magnified. *a* its outer division. *b*, its inner division; the rest of these members are exactly similar, and become changed into the six pair of cirri of Triton as exhibited in Plate X. fig. 1.

Fig. 7. Natural size and appearance of the animal after its metamorphosis.

Fig. 8. The same magnified, *e* rudiments of the eyes seen through the large valves of the operculum 5. the smaller valves are pointed out by fig. 6. *m* the opening or mouth of the valves, permitting the included animal to be seen. 1, 2, 3, 4 the valves of the body of the shell, separated by visible sutures. *b* the marginal projection of the basis.

Fig. 9. The same seen in profile, with the arms or cirri protruded *c*. 5, anterior valves of the operculum; 6, posterior valves. — 1, posterior valve of the basis; 2, valves nearest the posterior valve; 3, valves nearest the anterior valve; 4 anterior valve; *b*, basis.

Fig. 10. One of the cirri more highly magnified, to show that although pluri-articulate, they are as yet without ciliæ.

Fig. 11. A common full-grown Barnacle of the natural size (*Lepas balanus* Linn.) with the animal retracted; the figures of reference point out the corresponding valves in figure 8.

Fig. 12. The same in profile, in the act of throwing off its old skin or exuvium *c*.

PLATE X. Fig. 1, the exuvium of *Lepas balanus* magnified. *o* oviduct. 1, 2, 3, 4, 5, 6 the six pairs of arms, each consisting of two robust basil joints, supporting two branches or cirri, which are each composed of numerous articulations, ciliate on the opposite edges; those designated by the first three figures differ considerably from the others in being shorter and more robust, *m*, mouth, covered by the first or most anterior pair of members. *b*, cast of the body.

Fig. 2. One of the first pair of members more highly magnified.

Fig. 3. Labium ? highly magnified. + basis

Fig. 4. one of the first pair of maxillæ or jaws magnified in the same degree. + point of union. *a*, apex.

Fig. 5. One of the second pair of jaws, similarly magnified. *a*, toothed margin. + basis.

Fig. 6. One of the mandibles with its palp, also highly magnified. *a* toothed apex of the mandible. + apophysis for muscular attachment. *b*, palp

Fig. 7. *Lepas Balanus* or common acorn-shell seen from above and of its natural size, with the valves of the operculum open *m*, and the animal exerted *b*, in the act of throwing off its Exuvium *c*.

## NEBALIA

PLATE XI. Fig. 1, *Nebalia Herbstii*, after Dr. Leach, magnified ; the line beneath indicates its natural size. *c*, Clypeus. *t* tail or abdominal portion. *r*, beak. *e*, eyes. *a*, antennæ. *a* 2, anterior pair of feet. *f*, the 5 posterior or natatory feet of one side, with their bifid divisions. *s*, styles terminating the tail.

Fig. 2. *Nebalia Montagui*, magnified ; the same letters indicate corresponding parts of the former. *f* 2, short intermediate members. *f* 3, minute sub-abdominal fins.

## ERRATA.

Page 73, line 10 from the top .. *for* *Daphnia* *read* *Daphnia*.

74, " 15 from bottom .. *for* *Benache* *read* *Bernache*.

Fig. 1.

Fig. 5.



Fig. 3.



Fig. 4.



Fig. 2.



Fig. 6.



Fig. 7.



Fig. 8.

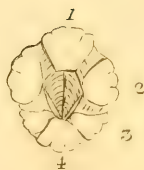
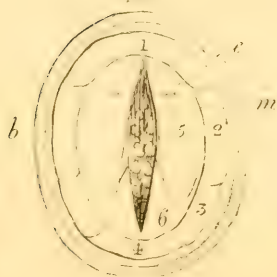


Fig. 11

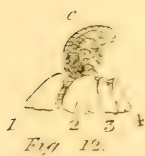


Fig. 12.



Fig. 10. x

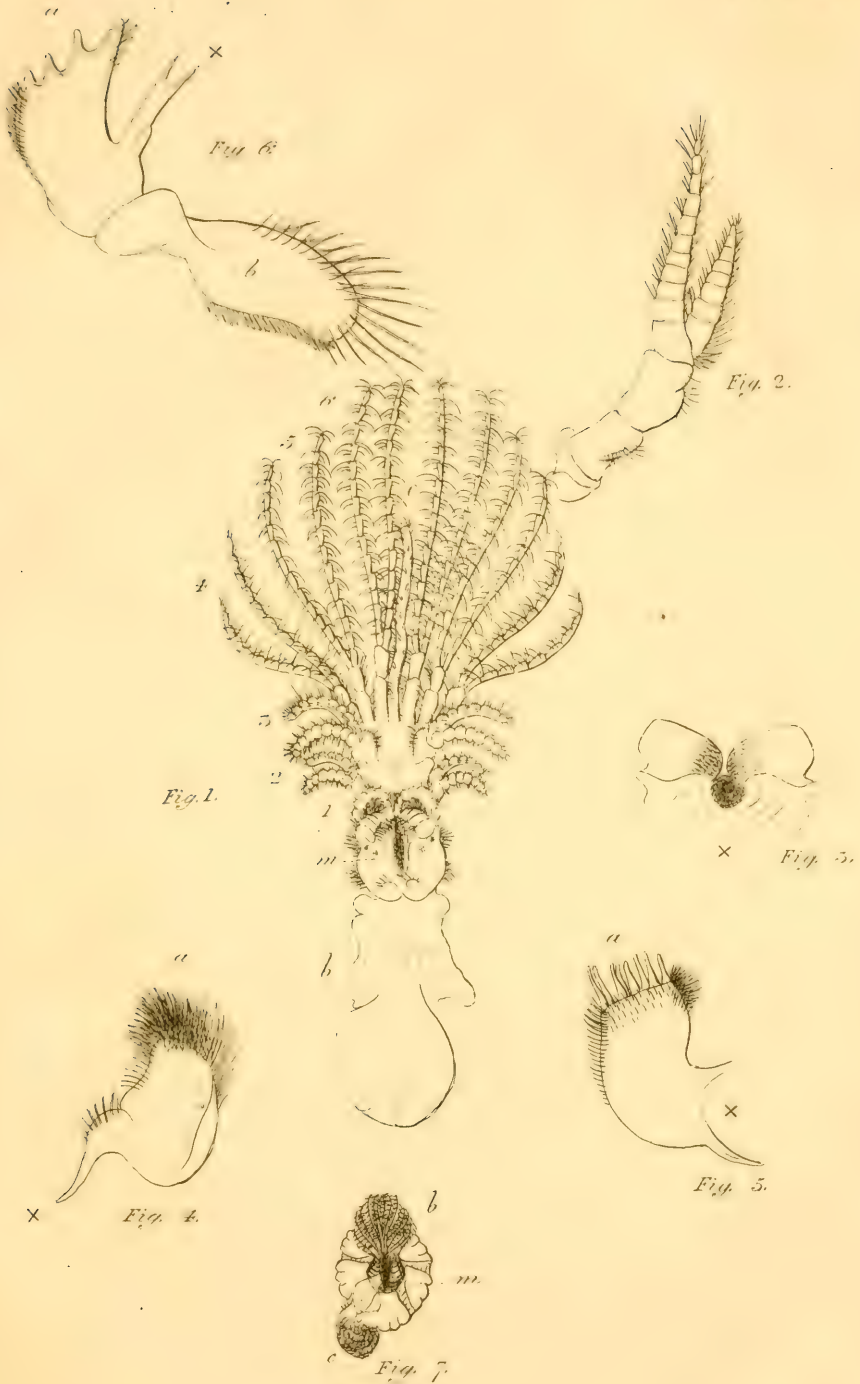


Fig. 9

# CIRRIPEDES.



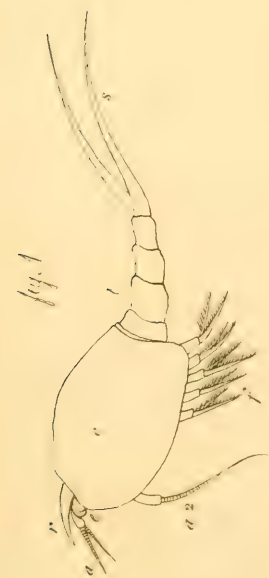




CIRRIPEDES.

INT. Del. et Sculp.





# NEBALIA.

*L.T.T. Sculp.*





## ZOOLOGICAL RESEARCHES.

### MEMOIR V.

*On Polyzoa, a new animal discovered as an inhabitant of some Zoophites — with a description of the newly instituted Genera of Pedicellaria and Vesicularia, and their Species.*

LINNÆUS whose vast and transcendant genius shed an equal lustre over the whole domain of Nature, would appear to have been the first to collect into one great assemblage (as an Order of his Class of Vermes) the various aquatic productions which under the disguise of Plant-like forms, seemed more nearly allied to the animal kingdom, and thence named Zoophites or animal-plants — these productions although in no way remarkable for their colouring, and many of them insignificant in point of size, are nevertheless amongst the most curious and interesting of Nature's works, embracing the principal part of the *compound animals*, or such as appear to be composed of a number of individuals united together and enjoying a life common to the whole ; this interest is farther enhanced by their appearing to have contributed no small share towards the changes which have taken place, and still continue to operate in modifying the crust of the Globe : the prodigious quantities of them which people the bottom of the Ocean

and often raise themselves to its very surface, is scarcely to be conceived by those who have not visited the warmer regions of the globe, where they appear at present to be in most active operation, at times extending themselves in an almost continuous sheet over the undulations and anfractuosities of the bottom of the sea for many leagues, and hundreds of leagues, forming submarine meadows and thickets of vast extent, that yield protection and cover to myriads of animals which lurk between their folds and contortions, or sport amongst their branch-like forms.— In texture some are fleshy, others fibrous, horny, or apparently lapidescent, and in form more various and dissimilar than the Lichens, these being the vegetables to which they most approximate in this respect; indeed until the beginning of the Eighteenth Century they were generally considered by Naturalists as Plants, yet Gesner in 1565, Imperati in 1599, Boccone in 1674, Shaw in 1638 and 1646, and some other Naturalists, had observed and described the animal inhabitant of several. To Peysonnel however must be given the chief merit of having drawn the attention of Naturalists to their real nature in his Memoirs presented to the Royal Academy of Sciences in 1727, and to the Royal Society of London and published in their Transactions for the year 1752—in these memoirs he has described the animals of many Madreporæ, Milleporæ, Gorgonias &c. To these interesting discoveries of Peysonnel, followed the no less important one of the naked Polypi by Trembley [See Trans. Roy. Soc. Vol 42, 43 and 44.] These were subsequently named Hydreæ by Linnæus and have been considered as the animal inhabitant (under certain modifications) of the greater part of the Zoophytes. In order to be enabled to appreciate the value of this opinion it will be necessary to understand the structure of these Hydreæ, which are eminently simple, soft, dilatable, and extensile, furnished with but a single central mouth or opening above, through

which the undigested part of their food is finally ejected ; this opening is surrounded by a number of prehensile tentacula capable of a remarkable degree of *extension* and *contraction* ; in their growth they resemble plants, pushing out branchings and ramifications, each branchlet forming a complete individual ; they appear to be entirely divested of any *regular* system of organs, circulating, nervous, or generative.

The Naturalists who have subsequently most contributed towards the knowledge of these Hydræ, are Bernard de Jussieu, Guetard and Donati ; but it is undoubtedly to Ellis we are under the greatest number of obligations for the length to which he prosecuted their natural History, and the descriptions and figures with which he has enriched this branch of knowledge.

Later investigators threw no new light upon these animals, so that Naturalists were satisfied of the identity of the animal inhabitant, and of the propriety of assimilating them in one connected group or Class, since however, that it has been deemed necessary to examine more minutely into the anatomical structure of animals, these notions have been disturbed by the discovery made by Renier in 1793. (*Opusc. scelt.* tom. 16 p. 256 t. 1.) that the animals of the Botryllus Stellatus were not Hydræ but Ascidie, and consequently appertaining to the *Mollusca acephala*, animals of a much higher Order, having a distinct respiratory organ, a mouth distinct from the Anus, a stomach, intestinal canal, ovaria, &c. It was reserved to Mons. Savigny however in 1815 and 16 to demonstrate that numberless Linnæan Alcyonii possess analogous animals with the Botryllus Stellatus. \* To these important dis-

\* Mem. sur les animaux sans vertebres. The designs which accompany the first of these Memoirs, M. Savigny says, were executed in 1810 and the Memoirs made known to the Institute in February 1815. Subsequently Messrs. Desmarests, jun. and Le Sueur (to whom these discoveries must have been known) analysed with equal success the animals of the Botryllus Stellatus and of the Pyrosoma.

coveries may be added those made by Le Sueur (*Trans. Acad. Nat. Sciences of Philadelphia*, Vol. 1. p. 176 t. viii.) that the animals of various Madrepores, of the Genera Caryophyllea, Astrea, Meandrina, &c. possess a considerably more complicated structure than Hydra, and one more nearly approaching to that of Zoantha and Actinia.

These several discoveries while they point out the dissimilar structure of the animal in the Zoophites, open a vast field for exploration.

The present Memoir has for its object to demonstrate another form of animal not hitherto known, and which while it must be allowed to belong to a new type of the Mollusca acephala, resembles exteriorly in some measure the Hydra, this animal has been designated by the name of Polyzoa, because it appears to be quite peculiar to the compound animals, and unlike Hydra, Actinia and Ascidia has never been observed in a single and separate state. The Polyzoa will probably be found in many dissimilar Genera of the Zoophites, and even mixed up with Hydra in some, as they appear to be in the Sertularia of authors, and hence this discovery must be the cause of extensive alterations and dismemberments in the Class with which they have hitherto been associated. Thus this discovery will remove that portion of the Sertularia not provided with distinct oviferous receptacles, to the class Mollusca acephala, as well as such other genera as may hereafter be found similarly circumstanced. I shall merely indicate here in a general way the whole of the Flustraceæ, in many of which I have clearly ascertained the animals to be Polyzoæ.

If amongst the Genera of the class of Zoophites, there is one which resembles a vegetable production in general appearance, roots, rapidity of growth and limited duration, more than any other, it is certainly that of Sertularia, a family so admirably illustrated by Mr. Ellis in his Natural



History of Corallines; it embraces, as at present constituted, a numerous assemblage of Plant-like animals of delicate and beautiful forms, composed of a tubular corneous substance, filled by the internal connection of the animals, which unites them together into one community, the animals showing themselves like so many stellate flowers from cells variously disposed along the stems and branches.

Linnaeus first instituted this Genus, including in it all the *tubular* corneous, and crustaceous Zoophites, and even several decidedly cellular. The subdivision of this heterogeneous family has consequently devolved upon the Naturalists of the present day, who have formed out of it a number of new genera, thus, Lamarek (*Hist. Nat. des Anim. sans Vertebres*) has Campanularia, Plumularia and Antennularia, Sertularia and Serialaria, formed out of the corneous Species alone; more lately Mons. Lamouroux, who has devoted his attention almost exclusively to Marine productions, (*Hist. des Polypiers flexibles*,) has increased the number of Genera to double the above amount, but, it is to be regretted, without having even adopted the names of those previously indicated by Lamarek, at the same time that he has enriched it with some new types: still, from the want of acquaintance with the animal inhabitant, both have left their Sertulariæ more or less heterogeneous.

As a whole, the Sertulariæ of Linnæus present us with the singular and unexpected result, of productions under great similitude of external appearance inhabited by animals not even Classically related!

In prosecuting the study of Marine productions, the Sertulariæ have fallen in an especial manner under the notice of the author, and presented a number of interesting results, but none so remarkable as the discovery of an animal inhabiting the presumed Sertularia imbricata of Adams? (*Trans. Linn. Soc. Vol. V, t. 2, f. 5-11*,) of a

totally different description from those the author had previously observed in the Campanulariæ, Plumulariæ, and genuine Sertulariæ of Lamarek, which are undoubted Hydræ. This new animal, the Polyzoa, was subsequently found in Sertularia Cuscuta, Spinosa, and Pustulosa, and will, no doubt, be found in all the other species not furnished with oviferous conceptacles, distinct in size, shape and situation from the cells occupied by the animals, and consequently in all the Sertularia of Lamarek.

The *Sertularia imbricata* of Adams being very imperfectly observed and figured, has scarcely been acknowledged by Naturalists as an animal production ; it is, in the harbour of Cove, one of the most obvious and common species, appearing as an amphibious parasite (Pl. I, f. 1.) on various littoral Fuci, particularly *F. serratus*, creeping over their surface by means of it's tubular ramifying roots, and throwing off numerous flaccid irregularly branched shoots to the length of from one inch to one and a half or more, often so densely clustered as entirely to cover the Fuci on which it grows ; the branches of this species go off in an alternate order from the stem and branches, decreasing in length from beneath upwards, and support at short intervals clusters of oblong sessile vesicles,\* imbricate or densely compacted, and unilateral in regard to the part of the stem on which they are respectively placed ; (f. 2,) these clusters vary in the number of individuals, from three to near twenty, with the intervals between the clusters at times short and indistinct ; the vesicles however are merely crowded and have no connexion with each other, except through the medium of the tubular stem on which they repose. When placed in sea water, the animals of this species shew themselves more freely and in greater numbers than those of any other submitted to examination. In their retracted

\* Vesicle is here used to signify the cells actually occupied by the animals, and not as applied to the true Sertulariæ where it means a larger description of cell or pod occupied by eggs only.

state the vesicles appear shortened and closed at the mouth (f. 3,) but from their translucency show the included animal with its arms closed together, (but neither shortened nor folded as they are in *Hydræ*,) with its body bent up, and lying in the bottom of the vesicle; when the animal protrudes, the closed mouth of the vesicle rolls outwards and extends, appearing to be continuous with the body of the animal, the arms or tentacula shoot out and spread into a funnel-like form, at the same time that the body of the animal becomes erect, (f. 4,) in this state it is easy to perceive the whole structure of the animal, its arms, gullet, stomach, intestine, and ovarium. The arms, (f. 4, a.) in this species are *ten* in number, half the entire length of the animal, and almost linear, and although incapable of any individual shortening or retraction, as in *Hydræ*, are extremely flexible, and have a range of delicate laminæ along their sides and front, which are kept in constant and rapid movement during their expanded state, calculated to produce a current towards the mouth and probably replacing the branchial apparatus of the *Ascidia*, as a somewhat analogous contrivance has been observed in the *Moluscous Genus Clio*. The mouth is placed within the circle formed by the arms, from which the gullet, (*b*,) extends downwards to the stomach, (*c*,) which occupies the middle point of the vesicle, and is of a roundish figure and fleshy substance; from the lower part of the stomach the intestine, (*d*,) bends upwards along the front towards the edge of the vesicle; in it, scybala or rounded pellets of dark encrementitious matter may generally be observed. By attentive observation a muscle may be seen to act in drawing up the animal, originating near the margin of the vesicle above, and inserted into the animal beneath the stomach; no doubt, it possesses an antagonist calculated to draw the animal within its cell, and originating of course, in the lower part of the vesicle. From the stomach, the viscus



(e,) appears to descend considerably lower, and from its acquiring a spherical shape, opaque yellowish colour, and its persisting after the death of the animals in many of these Zoophytes, is most probably an ovum or ovarium, and quite analagous in situation, with the same organ in the lately discovered compound Ascidiæ.

The discovery of the Polyzoa was made in the summer of 1820 ; during the subsequent and following seasons, an exactly similar structure was noticed in the other species above enumerated, and in a new type which perhaps merits to be distinguished as a separate genus, under the title of *Pedicellaria*,\* (Pl. II. f. 5, 6, 7,) as the vesicles are single and *terminal*, each supported by a simple pedicle, originating in a scattered manner, from creeping, slightly branched tubular roots. The *Pedicellaria* was discovered on the bottom of a ship from the United States, mixed with *Campanularia Aucta*, (a new species) and other marine productions. In this type the arms are *twelve* in number, and the mouth of the animal and tentacula when protruded, incline in a remarkable degree to one side. I for some time thought the *Sertularia Syringa* might belong to this last type, as it has not been observed to produce any oviferous conceptacles, and although remarkably smaller, bears a considerable resemblance to *Pedicellaria*, but as its animal has been since ascertained to be a *Hydra*, its relation to *Campanularia* remains undisturbed.

The Comparative Anatomist will find no difficulty in tracing a considerable agreement in structure between Polyzoa and that of the compound Ascidiæ so admirably developed and so elegantly figured in the Memoirs of Mons. Savigny ; the Polyzoa however are still essentially different, and this difference consists principally in the substitution of external prehensile tentacula, to which the branchia or respiratory

\* Muller's genus *Pêdicellaria*, had been erroneously founded on certain productions mixed with the spines in *Echini*, which are certainly nothing but peculiar organs belonging to the animal.



organ is appended, in place of the internal branchial sac of the compound Ascidia. These last (the compound Ascidia) on a general view, having a lobed or valvular opening, leading to a capacious branchial cavity or sac, over the parieties of which the branchia are distributed; at the bottom of this cavity is found the real mouth of the animal, leading through a gullet more or less long to the stomach, which is thick and muscular; from the lower end of this, the intestine issues and shortly bending upwards, terminates near the front of the branchial opening; the ovarium is either situated in the fold formed by the intestine on one or both sides of the animal, or is appended to the lower part of the fold, and sends its oviduct upwards along the course of the rectum; all these parts are included within a common or exterior tunic, whether the individuals are simple or compound.

The other species of Sertularia in which the animals have been determined to be Polyzoa, may, together with Sertularia imbricata of Adams, perhaps, be referred to *one* Genus, although they differ remarkably in habit, in the arrangement of the vesicles, and even in the number of tentacula, which vary from eight to ten, being in Sertularia Pustulosa, Spinosa and Cuscuta 8, in S. imbricata 10. To this Genus the name of Vesicularia may not be thought inapplicable, and as the individuals which compose it have been hitherto very imperfectly understood, a short description of each, illustrated by magnified figures, must prove satisfactory to the Zoological Student.

*Vesicularia Cuscuta* (Sertularia of authors,) (Pl. II. f. 1.) bears some slight resemblance to V. imbricata before described, in the flaccidity of its branches, and the irregular distribution of its vesicles, these however on close examination are found to be much fewer in number and much more scattered, at the same time that the whole is infinitely smaller, being indeed the most delicate species known,

while its flexuose shoots often extend to the length of several inches, very much like the plant from which it has obtained its trivial name (viz. *Cuscuta* or *Dodder*.) The main stems originate from tubular creeping roots, which invest marine plants in shoal water, these stems are often jointed at unequal distances, and give off a number of short branches, which originate in pairs from its opposite sides, frequently just above a visible joint; these branches support the vesicles, which are scattered over their surface in an irregular manner, and do not differ except in size and number of tentacula, from those of *V. imbricata*; the tentacula being 8 in number.(f. 4.)

*Vesicularia spinosa* (*Sertularia* of authors) (Pl. III. f.1.) is indeed a production of the greatest beauty and delicacy when in its prime, and of quite a peculiar air and habit, the vesicles however with their animals exactly accord with those of the last species, only that the former are more turgid or of an oblong oval shape. The stem in this species rises from a tuft of tubular intricate roots, and is more or less thick in proportion to the age of the individual, a circumstance also met with in some of the true *Sertularia* (viz. *Campanularia verticillata* and *Sertularia Halecina*.) and as its thickening arises from the constant addition of fresh radical tubes to its outer surface, it is probable that every new branch in these species sends downwards its radical tube along the surface of the stems, so as to give them the requisite strength, in proportion to the growth of the upper part; this stem sends off branches in an alternate and irregular order, which are erect and zigzag, and become extremely fine towards their upper extremities; at each angle of the zigzag, a pair of short repeatedly dichotomous branches are given off, the last divisions ending in sharp or spinous-like points. (f. 5.)

The joints of the stem, as well as the joints of the branchlets, are each provided with a row of three prominent holes

on their upper surface, upon which in many we perceive an equal number of oval transparent vesicles, or towards the extreme parts of the branches, embryo vesicles. The animals are very easily seen in all their details in this species, from the great transparency of the vesicles, and are provided with *eight* tentacula. (f. 7, 8.)

*Vesicularia pustulosa* (Sertularia of authors). This species, very imperfectly known from the perishable nature of its vesicles, first offered itself to notice without them and as represented by Ellis N. Hist. of Corallines Pl. XXVII. *b*, B. but was subsequently discovered in its perfect state (Pl. I. F. 5.) It arises from the surface of marine fuci with a straight flexuose stem, to the height of two or three inches, giving off at each flexure a spreading branch, which in like manner gives off secondary ones, all however, both primary and secondary, lying in the same plane, they are hence what Botanists term distich; each flexure of the stem and branches and each terminal branchlet is composed of a distinct joint, each of which are perforated by a double row of holes from 6 to 18 with elevated margins, fig. 7, 8, on all of which in perfect specimens are placed oval transparent vesicles, furnished with animals having 8 tentacula, fig. 10 11; the rows of perforations having a spiral tendency, the clusters of vesicles hence present themselves in every direction (f. 6,—) this species approximates in this last character and in the unilateral regular disposition of its vesicles to *Serialaria*, from which however all the *Vesiculariæ* differ in the vesicles being *free* and not as in that genus agglutinated together in series or connected lines. Although the animals of the *Serialaria* have not as yet been observed, yet from the above coincidences and no oviferous vesicles distinct from the others having been seen upon them, there can hardly be a doubt but they are the habitations of *Polyzoæ* and not of *Hydræ*, and consequently would find place in our Systems next to *Vesicularia*, and distinguished as a genus by

the vesicles being confluent or united together by their sides, either in interrupted series or apparently continued lines.

Time and more accurate observation will no doubt add many more species to the above Genera, even from amongst the Sertulariæ already known ; thus the Sertularia cedrina, obsoleta and pinus of Gmelin are probably Vesiculariæ, as well as Sertularia uva of Ellis which might be considered as the young state of Vesicularia imbricata but for the statement of that acute observer, that the animals possess only *eight* arms, whereas in the latter they are provided with 10.

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POLYZOA.

PLATE I. Fig. 1, *Vesicularia imbricata*, a principle stock of its natural size.

Fig. 2. One of the terminal branches magnified, showing the animal in different states of projection.

Fig. 3. One of the vesicles highly magnified with the animal in its retracted state.

Fig. 4. The same with the animal in its state of extension: *a*, tentacula. *b*, gullet. *c*, stomach. *d*, intestine. *e*, ovarium. Two pellets of excrementitious matter are seen in the intestine.

Fig. 5. *Vesicularia pustulosa*, in its perfect state when full grown, natural size.

Fig. 6. A branchlet magnified, showing the sub-spiral distribution of its groups of vesicles.

Fig. 7. A branchlet highly magnified, partly denuded by the falling off of the vesicles, showing the exerted animals, and the articuli into which it appears to be divided.

Fig. 8. One of the terminal shoots, without its vesicles, magnified.

Fig. 9. A vesicle with the animal in its retracted state, magnified.

Fig. 10. A vesicle with its animal exerted, magnified. *a*, tentacula. *b*, gullet. *c*, stomach. *d*, intestine. *e*, ovarium.

Fig. 11. The tentacular head more highly magnified.

PLATE II. Fig. 1. *a*, Natural size of a principal stock of *Vesicularia Cuscuta*. *b*, the same magnified.

Fig. 2. A terminal shoot from which the vesicles have fallen off, showing the irregular distribution of the perforations on which they were placed.

Fig. 3. A vesicle highly magnified, with the animal in its retracted state.

Fig. 4. A vesicle with the animal in its extended state. *a*, tentacula. *b*, gullet. *c*, stomach. *d*, intestine. *e*, ovary.

Fig. 5. *a*, *Pedicellaria exotica* of its natural size. 5 *b*, the same magnified, showing a number of individuals originating from one of the radical tubes.

Fig. 6. A vesicle highly magnified with the animal retracted and bent up as usual into an S like form.

Fig. 7. A vesicle highly magnified with the animal extended, its details obscured by the greater opacity of its parieties.

Fig. 8. One of tentacula more highly magnified showing the respiratory lamina in profile.

PLATE III. Fig. 1. A principal branch of *Vesicularia spinosa* of the natural size.

Fig. 2. A dead branch stript of its vesicles, as usually seen amongst the rejectamenta of the Sea.

Fig. 3. The basis of an old stock formed by an accumulation of tubes, giving rise to branches similarly constructed, magnified.

Fig. 4. Three joints of a main branch magnified, showing the manner in which the vesicles were distributed upon it, and the ramuli given off in pairs.

Fig. 5. One of the two ramuli which are given off at each articulation of a branch highly magnified, and still retaining a portion of its vesicles, from some of which the animals are seen projected, while others appear not to have reached their state of perfection

Fig. 6. One of the vesicles very highly magnified with the animal in its retracted state.

Fig. 7. One of the vesicles with the animal extended. *a*, tentacula. *b*, gullet. *c*, stomach. *d*, intestine with scybala. *e*, ovary.

Fig. 8. Front view of the tentacula and open mouth of the animal.

Fig. 9. *a*, One of the tentacula rolled upon itself at the extremity. *b*, a tentaculum wholly revolute.

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END OF PART I.



## VESICULARIA.







VESICULARIA.





VESICULARIA.





# ZOOLOGICAL RESEARCHES.

## MEMOIR VI.

*Developement of Artemis Salinus, or Brine Shrimp ; demonstrative of its relationship to Branchipus and the other Crustaceous Phyllopoda, and to those enigmatical Fossils, the apparently eyeless Trilobites... with a new species of Artemis and of Apus.*

Amongst the Fossil remains of animals, it may be remarked, that some have no *existing* type, that others present a doubtful character, while many are indisputably allied to some of the members of the *present race*. . . of this last description are the Trilobites with *evident eyes*, now forming the Genera of Calymena and Asaphus, and which are evidently related, through Apus (Pl. 6, f. 3), to the Crustaceous Phyllopoda ; of the first description, have been regarded, the apparently eyeless Trilobites of the Genera Ogygia, Bucephalithus, and Paradoxides, and which it is one of the objects of the present Memoir to show, are equally related to the same tribe, through Artemis, now for the first time described with the requisite detail.

The immense quantity and great variety of animal remains, imbedded in the rocks which compose the crust of our globe, has so identified the study of Geology and Zoology, that the student of the former science, can no longer prosecute it in a satisfactory manner without the aid of the latter, neither will a slight knowledge of Zoology avail, as may be learnt from the substance of the present Memoir, and from the unavailing guesses of the older Naturalists, as to the type of the Trilobites, many believing them to be *trilobed shells*, (as Schreber, Lehmann, Klein, Luyd, Wolstersdorf, &c.) . . others likened them to the Chitons (Sclotheims), others to the Onisci (Walch), and some even regarded them as aquatic larva, and the Bucephalithus (Pl. 5, f. 1) in particular, as having some affinity with the Scolopendra ! (Beckman).

Satisfactory as it may be to the Philosopher, the Geologist, and to the Natural Historian, to be able to discover and point out the analogies which connect the fossilized with the existing race of animals and plants,\* we shall perceive, that it is no less important to determine the exact species which any particular bed or formation presents to our view, these bodies being found to determine with much greater certainty, the *identity* of mineral deposits, than characters taken from the Rocks themselves, which every experienced Geologist knows to vary considerably in colour, density, and many other particulars, even within a very limited distance ; they declare even more in regard to strata, by pointing out the respective Epochs of their formation, and hence, have been emphatically termed, the Medals of Creation.

\* See my Memoir on Pentacrinus Europæus.

Taking a general view of the existing Phyllopora, they present us with two distinct types, the one, *Apus* (Pl. 6, f. 3), with the series of members, numerous (upwards of 20) and close, the first pair constituting a trifid kind of rowers or feelers, the eleventh bearing on each side a bivalve oviferous cell; the body in this type is covered in great part by a dorsal clypeus, attached only to the head, furnished with a pair of approximate sessile eyes above, and with a pair of minute antennæ beneath; to this type the Eyed Trilobites *Calymena* and *Asaphus* most approximate, the principal difference being in the comparatively short Clypeus, covering only the head and mouth, and in the posterior part terminating with the last pair of members, and not being produced into a tail; as we know nothing of the structure of the under side of these fossils, which is invariably engaged in the rock upon which they repose, it remains undetermined whether they were provided with rowers and antennæ, it is certain, however, that the Dudley Trilobite is sometimes accompanied by subulate jointed bodies, which have been supposed the remains of these members.\* The other type, *Artemis*, (Pl. 1), has eleven concordant members, less closely set, a tail of eight joints, no clypeus whatever, peduncled moveable eyes, conspicuous antennæ, and both sexes with a pair of horns, or rather appendages, sometimes remarkably large in the male, smaller in the female, which has a single oviferous sac attached beneath to near the root of the tail; to this type the existing Genera of *Branchipus*, *Eulimena* and *Chirocephalus* belong, with an approximation in the fossil Genera of *Bucephalithus* (Pl. 5, f. 1, 2, 3), *Ogygia* (Pl. 6, f. 1, 2), and *Paradoxides*, (Pl. 5, f. 4, 5, &c.); these differ, however, from the existing race much in the same manner as the former type, in the want of a tail, as well as in the members being much more numerous. Linnaeus has given a figure of *Bucephalithus Spinulosus* with antennæ, the existence of which may be presumed, together with that of the pedunculate eyes, which have not as yet however been noticed even detached.

What principally distinguishes this tribe of Crustacea, is the total deprivation of proper feet, which are entirely converted into a kind of leaf-like complicated fins, solely adapted to swimming, hence the term *Apus* applied to one of the Genera. We shall be the less surprized at this, when we recognize a similar conversion of feet into fins even in some of the higher classes of animals, as, for example, in the *Trichechus* of the *Mammalia*, the whole of the *Cetacea*, and in the *Marine Turtles*.

### *Of Artemis, or Brine Shrimp.*

The minute and rare animal which constitutes the type of this Genus, being very imperfectly known, and consequently its place in the class Crustacea indeterminable, induced me to procure some from the *Lymington Salt Pans*, which was effected with considerable difficulty, the few that reached Cork being dead, and the *Brine*

\* It having been lately announced in several Journals, that an American Gentleman had discovered and brought home from the Falkland Islands, specimens of an animal supposed to be the existing type of the Trilobites, I may just observe in the absence of details, that the animals in question are most likely to be the *Oniscus Paradoxus* of the *Systema Naturæ*, "*Antennis quaternis, segmentorum lateribus fulcato spinosis*," an inhabitant of the same seas near *Terra del Fuego*, and long ago pointed to, as probably related to the animals in question.



reduced to a few drops ; as there were several females amongst them with mature ova, and conceiving that the remnant of Brine might still contain the requisite number of its peculiar animalcula to originate a sufficient stock of appropriate food for any of the Brine Shrimp that might hatch, I put it, together with the oviferous conceptacles of the females, into an artificial Brine, and had the satisfaction to see my hopes realized by the birth of several individuals, some few of which lived, went through their several stages of evolution, and finally attained to near their full growth.

The *Artemis Salinus* or Brine Shrimp, is a very small and delicate animal, when full grown about half an inch in length, of considerable transparency, slightly tinged with yellow, and with a highly polished surface ; nature having constructed them with members solely adapted to swimming, they seem to be in perpetual pursuit of prey, gliding with an almost even motion through the water, and moving with equal indifference and facility on the back, belly or sides ; the shape of the animal, the undulating movement of its fins, and the glossy appearance of its coat, render it an object of a very interesting description, more especially when apprized that analogous animals appear to have been the first created conspicuous inhabitants of the primitive fluid, of which these may be regarded as a degenerate or pigmy race. Hitherto the only localities in which these little animals have been observed, are some salt lakes in Siberia, and the Salt-pans at Lymington ; in these situations, however, they occur in the greatest abundance, and at the last named place, making their appearance in the early part of spring, multiplying beyond conception during the summer and autumn, and disappearing during the winter months, a phenomenon common to many of the smaller Crustacea. As in all salt works the pits have different destinations, it must be observed, that they are not found indiscriminately in all, but principally in the tanks called clearers, in which the brine acquires such strength as to furnish 4 oz. of salt to the pint measure ; by the account with which Mr. Racket has favoured us, (Linn. Trans., vol xi.), it would appear that the workmen attribute to them the property of assisting in the clearing of the brine, and hence transport them to such tanks as seem to be without them. How they came originally to the Salterns at Lymington, and what animalcula live in so strong a solution to afford them food, must be left to future investigators placed under more favourable circumstances.

If closely observed, the head appears furnished with a pair of spreading eyes, easily distinguished by their black colour, with a pair of filiform antennæ, and further with a pair of lateral appendages, of considerable size in the male, inclined towards the belly of the animal ; the anterior half of the body shews a close row of lateral fin-like members, and deeply fringed ; the posterior half is linear, extended, and ends in a fork.

The gradual developement of the Embryo, and the metamorphoses it undergoes from its first production until arrived at a perfect or adult state, will be found to correspond with those noticed in *Branchipus*, *Chirocephalus* and *Apus*, animals with which its alliance can no longer remain doubtful.

The *Ova* are suborbicular in form, and of a dark brown colour, and in giving birth to the animal, split at one side, and so allow it to escape; at this stage the embryo appears of an orange colour, and a pyriform figure, and still remains attached to the opening by its narrow end, (Pl. 2, f. 6, *b*), all its members being enveloped within a second tunic, in which state *it is buoyed up in the water* above the flocculi which rest upon the bottom of the vessel, and shortly makes its escape from the enveloping tunic, and swims about, but with no great vivacity, under the form represented, Fig. 7, viz. that of a Monoculus of the Genus *Amymone* of Muller; here we have a singular instance of the provident care of nature for the preservation of the young, well worthy the attention of the philosophic naturalist, for were they to be born at the bottom of the water, and enveloped in sediment and flocculi, scarcely any would escape that destruction, which we observe to await such as incautiously become entangled in it. In this first stage of the animal's existence, it is of an ovate form, with three rowers on each side, which move in concert; the anterior pair of rowers are the smallest, composed of three joints, and terminate in three bristles, these are probably the masked antennæ of the perfect animal; the second pair of rowers are the largest of all, composed of three broad confluent joints, lobed and fringed beneath with bristles, these, as we shall see, become the horns of the perfect animal; the third and last pair of rowers are also slightly lobed beneath, and furnished with a few bristles. At the end of several days, no other alteration takes place in the animal than the more complete developement of its rowers, and the elongation of its tail, which appears slightly indented at the sides: Pl. 2, f. 8, it is still a Monoculus, or provided with but one sessile eye.

As its growth and evolution go on progressively, it is observed to acquire a pair of sessile eyes, *in addition* to the original *one*, the great rowers become remarkably larger in proportion, the body and caudal extremity elongate, and the permanent members gradually unfold themselves, and become effective, the anterior pairs first (Pl. 2, f. 8); before the whole of these are perfectly developed, the lateral pair of eyes become more salient, and at length pedunculated, the whole of the original rowers become immoveable, the tail bifurcates at its extremity, and the animal only awaits the last change to acquire its perfect form, or nearly such as we see (Pl. 1, f. 2)... During these progressive changes, like all the analogous Crustacea, it no doubt throws off its exuvium very frequently, in order that its crustaceous covering may be suited to the change of form and size of the animal, but from the large capacity of the glass-vessel in which the observed specimens were kept, the flocculi with which its bottom was covered, and the fondness of the animal during its latter stages to perforate through these in every direction, neither the exuvia nor the act of throwing them off, could be perceived, with the exception of one or two of the last casts.

With regard to the period occupied by the entire evolution of the animal, it must be observed that those subjected to notice, came to hand at the commencement of winter, the most unfavourable season to judge of the more common length of this period, as cold weather has been found to retard the progress, and warmth to hasten it, in many of the other Entomostraca; another circumstance which un-



doubtedly contributed to render the period longer than usual, must have been the absence or deficiency of the requisite kind of food or animalcula; bearing in mind these considerations, it may be stated, that during six weeks the larva retained its original rowers and its sessile eyes, as in fig. 9, while the permanent members were not fully developed; at the end of two months, dark excrementitious matter first appeared in the intestinal canal, the lateral eyes became pedunculated, the whole of the members were complete, and the great rowers were first converted into horns, and the antennæ shewed a considerable degree of elongation, but it required full two months and a half to render the animal perfect, and capable of propagating its species.

Although many of the Entomostraca will be found to present themselves first under a similarly masked form (*Amymone*), yet the peculiar changes noticed above are confined to the Phyllopoda with pedunculated eyes, which alone furnish the singular spectacle of *Monoculi*, *Trinoculi*, and *Binoculi*, or in other words, of an animal possessed of one, three, and at length of but two eyes, during the life of the same individual.

### *Other Species of Artemis.*

Amongst several minute Crustacea sent me by the Rev. Lansdown Guilding, from the West Indies, was one female probably of this Genus (Pl. 1, f. 11, 12); to that gentleman, after whom I have named it, and who is one of the most zealous and intelligent Naturalists the West Indies had ever to boast of, I must leave its natural history. See Explanation of Plate I. for details.

The *Eulimena* of Latreille, which Dr. Leach considers a species of *Artemis*, found in the Mediterranean, seems to require further elucidation.

The *Branchipus Paludosis*, (Pl. 3, f. 6), I consider as a fourth species of *Artemis*.---This, which is a native of swamps in Greenland, attains to the length of three quarters of an inch, has smaller horns than *A. Salinus*, the tail terminated by a pair of plumose setæ, and the oviferous sac of the female of an elongated form.

### *Chierocephalus.*

This Genus, instituted by Prevost, is distinguished from *Artemis* by the very complicated apparatus situated between the basis of the Great Horns in the male (Pl. 3, f. 4 and 5, Pl. 4, f. 1), and in the horns being much smaller; for details I may refer to Prevost's *Memoir*, p. 201, pl. 20, 21, and 22. Desmarest makes this synonymous with *B. Paludosis*, and it appears to have been confounded with the *Branchipus Stagnalis* by most authors. This would appear to be the most common and widely distributed of the whole of this peculiar tribe: it seems to be that species first described by Mr. Ed. King, in the *Phil. Trans.* 1667, vol. 57, p. 72. 74, being discovered by that gentleman in a ditch near Norwich, and has been more lately elucidated by Dr. Shaw in the *Linneæan Transactions*. In France it has been noticed in the marshes of Fontainebleau and Bondy, in ditches about Meudon near to Paris, and in ditches which border on the route from Castillon to Sainte-Foi.---Both Shaw and Prevost

have given its progress from the egg, which corresponds with the changes observed in *Artemis*, and indeed the latter author has favoured us with such full and accurate details of its structure, and such excellent figures, as to leave little to desire on this subject.

### *Branchipus.*

By the removal of the two former animals, this Genus will be restricted to one species, viz. *B. Stagnalis* (the *Apus Pisciformis* of Schœffer), Pl. 3, f. 1, 2, 3, the male; Pl. 4, f. 2, head of female. This, which appears to be a comparatively rare animal, is distinguished by what seem to be *two pair* of antennæ in the male. The Horns are rather small, and bifurcate at the extremity; the tail terminating in two taper ciliated scales. Found by Schœffer in a ditch by the road which leads from Ratisbon to the town of St. Nicholas.

### *Apus Guildingi; a new species.*

This, I received together with the *Artemis Guildingi* from the West Indies, and having as yet no details, must leave its history in the hands of its distinguished discoverer. It is of a light blackish colour, the clypeus translucent, almost membranous, and shorter in proportion than in any of the known species, with the extreme branch of the anterior member extremely long; in other respects it differs from them but little. . . I may here observe, that there appears to be two European species confounded under the specific name *Cancriformis*, viz. Schœffer's and Dr. Leach's, which most resemble the above species, and that detailed by Mons. Savigny, in which the elongated *Clypeus* entirely covers the natatory members.

### *Of the Fossil Genera, Bucephalithus & Ogygia, &c.*

The Fossils which constitute these Genera, and the other Eyeless Trilobites, which form Mons. Desmarest's Genus *Paradoxides*, are but little known to British Geologists, are only found in a particular part of Sweden, and in one locality in France, and are extremely rare in Collections, even in those countries; interesting as they are from these circumstances, and their appearing to have been the first created animals, they come doubly recommended to our notice since the discovery of the living type in *Artemis*, which seems to connect them with the present race. Unlike those almost microscopic Crustacea, however, these present us with animals of gigantic size in comparison, many of them having exceeded a foot in length; and as all the other individuals of this tribe are provided with a distinct organ of vision, even in their larva state, analogy will not permit us to believe that they were absolutely deprived of sight, which to an animal of such size, and possessing locomotive powers, must have been indispensable to the pursuit and capture of its prey. When it is considered, that these fossils are very rarely found entire, but almost always in detached portions, it is not surprising that these delicate members, seated on a narrow pedicle, and articulated to the sides of the head by membrane only, should have been lost, and their point of attachment rendered inconspicuous.



*Bucephalithus, &c.*

A knowledge of the structure of *Artemis* has enabled me to propose this Genus, Pl. 5, f. 1, 2, 3, to which it shows a considerable approximation. It is composed of the *Entomolithus Paradoxus* of Linnæus, Pl. 5, f. 1, the *Entomolithus Bucephalus*, f. 2, and *Spinulosus*, f. 3, of Wallenberg. As these, together with the other Eyeless Trilobites which constitute the Genus *Paradoxides* of Desmarest, are only found in a particular formation in Sweden, it will be advantageous to describe this formation before entering into further details.

The Transition formation in Sweden, appears to consist of three kinds of stratified rocks, viz. 1st, Alum-slate, containing beds of swine-stone, this, which is the lowest in position, contains the Eyeless Trilobites, which are not found in any other stratum, and are associated with a very small ammonite. . . 2d, a dark coloured Transition Lime-stone, placed over the former, the most essential of the three strata, containing a variety of fossils, but principally large *Orthoceratites* and *Entomostracites*, . . and 3d, Argillaceous Shistus, very different from the aluminous shistus, never containing swine-stone or other calcareous matter. Its fossils are as it were derived from the calcareous stratum, over which it is placed, but they are so reduced in size and so thin, that they mostly appear as impressions (*Grapsolithes*). This last stratum is found but in a single Province.

The Alum works Mr. Wallenberg points out as the most productive of these extraordinary fossils, are as follows, viz. "Those which are opened on the eastern side of Mount Faredalsberget, and particularly that called Olstrop, in the parish of Dimbo, which have yielded the largest individuals. But it is particularly in a new Alum-work named Damman, opened on the north side of Mount Billigen, where they can be procured at the present time."

The *Bucephalithus Tessini*, Pl. 5, f. 1, Mr. Wallenberg, from its fragments, says it must have attained to above a foot in length; front semilunar, furnished with large recurved horns; (the dotted line in the figure is from that given in Desmarest's Work on the Trilobites.) A great peculiarity in these *Bucephalithi*, is the whole of the members being perfectly distinct, and unconnected at their extremities. This species is only found in the Aluminous Shistus of Westrogothland, and at such a depth as the quarries scarcely attain at the present time (1818,) the shist being too hard for the purpose of procuring alum.

The *Entomostracites Bucephalus* of Wallenberg, of which f. 2 is the anterior portion, I should regard as the female of the former, differing in the horns being much smaller, and extending outwards. With the former species, it is found in the *inferior* aluminous shistus, and in the adjacent swine-stone, but as yet, only the Head is known. The impressions obtained at Dimbo indicate an animal of large size, as the Horns are as long as four inches!

*Bucephalithus Spinulosus*, Pl. 5, f. 3, is the Trilobite figured by Linnæus as provided with Antennæ, Vest. Act. Handl. 1759, p. 22, t. 1, f. 1. Mr. Wallenberg has never seen any trace of antennæ and Mons. Desmarests endeavours to explain this supposed error of the

illustrious author of the *Syst. Naturæ*. Entire specimens are only found in the Quarry of Alum-slate of Andrarum in Scania, (that figured by Mons. Desmarest is upwards of two inches in length) ; fragments, on the contrary, are abundant over the whole of Westrogothland. I must not neglect to point out a semicircular inscription at the side of the head, Mr. Wallenberg says, almost as in the *B. Tessini*.

For the benefit of Geologists who have not seen Mr. Wallenberg's Essay on these animals, nor the transcript in the *Journal de Physique* for July 1820, nor Mons. Desmarest's work, I have added figures of the other Eyeless Trilobites of Sweden, viz. *Paradoxides Scaraboides*, Pl. 5, f. 5, and *Paradoxides Gibbosus*, Pl. 5, f. 4. . both of these appear to be very common in the Aluminous formation, and particularly in the included swine-stone.

### *Ogygia*.

This Genus, so named from appearing to possess the greatest antiquity of all the Fossils of the Transition formation, like the former, is extremely local, and has never been observed but in the roofing slate of Angers, in France. Whether the *two* species met with, are really such, or only indicate a sexual difference, is doubtful; I incline to the latter opinion, and consider *O. Desmaresti*, Pl. 6, f. 2, as the male, *O. Guettardi* as the female, which is rendered more probable by Mons. Desmarest having observed in a full grown specimen, an oval pad on each side of the tail, much thicker than the rest of the body, and hence corresponding, in some measure, with the oviferous conceptacles in *Apus*.

This Genus differs from *Bucephalithus*, in the members being apparently connected together, or perhaps covered by a membranous expansion. There is a division in front between the Horns, and another flexuose articulation at the side of the Head, as in the former Genus, the Horns being extended backwards along the sides of the body, from which they are, nevertheless, quite separate. . . What Desmarest considers as oculiform protuberances, I consider, as the places of the mandibles.

*Ogygia Guettardi*, Pl. 6, f. 1, rarely found entire in the roofing slate near Angers, its fragments, on the contrary, are very common; varies in size from about 4 inches to near a foot in length !

*Ogygia Desmaresti*, found with the former, I consider as the male; it is altogether much broader in proportion, and the Horns very broad but rather shorter and more spreading. . . probably attains the length of near 15 inches ! but has not been met with entire.



## Explanation of the Plates.

### PLATE I.

ARTEMIS SALINUS.—Fig. 1. Of the natural size.

- Fig. 2. Male, magnified, from beneath.
- 3. Do. fore parts, from above.
- 4. Do. Head with the Horn-like appendages forced forwards, out of their natural position.
- 5. The labrum, more magnified.
- 6. The left Maxilla.
- 7. One of the Mandibles, still more amplified.
- 8. The second pair of Maxilla.
- 9. One of the limbs; *a*, basil joint; *b*, ciliated paddle; *c*, pectinated scale; *d*, digitated lobuli; *e*, branchial sac; *f*, ciliated scale.
- 10. Do. in a different position: the same letters mark the corresponding parts. In this view the branchial sac is better seen.

ARTEMIS GULDINGI.—Fig. 11. Female magnified.

- Fig. 12. Under side of the abdominal portion, showing the biarticulate oviferous sac.

### PLATE II.

ARTEMIS SALINUS.—Fig. 1. Head of the female, magnified, from beneath.

- Fig. 2. One of the Horn-like appendages more magnified.
- 3. The oviferous sac, attached to the upper part of the abdominal portion.
- 4. End of the tail in the female.
- 5. Tail part, of a younger individual, showing distinctly, its joints; which appear preternaturally contracted.
- 6. *a*, Ovum greatly magnified; *b*, giving birth to the Embryo.
- 7. Larva when fully expanded, still more magnified.
- 8. Do.. after some days' growth.
- 9. Do.. showing a greater approximation to the perfect animal.

### PLATE III.

BRANCHIPUS SCHCEFFERI (*Stagnalis*).—Fig. 1. Male of the natural size.

- Fig. 2. Magnified, with the horn-like appendages thrown forwards, to show the labrum and mandibles.—Fig. 3. Front view of the head.

CHIEROCEPHALUS PREVOSTII.—Fig. 5. Male of the natural size, from beneath.

- Fig. 4. The curious and complicated apparatus, extended, which is situated between the roots of the Horn-like appendages, greatly magnified.

ARTEMIS FABRICII (*Branchipus Paludosis*).—Fig. 6. Female, magnified.

### PLATE IV.

CHIEROCEPHALUS PREVOSTII.—Fig. 1. Female of the natural size.

- Fig. 5. Ova. 6. Much magnified.
- 7. Larva in its first stage, magnified.
- 8. Do. second stage.
- 9. Do.. approximating to the perfect animal, of seven days' growth.

BRANCHIPUS SCHCEFFERI.—Fig. 2. Head of female magnified.

- Fig. 3. Ova of do. 4. Do. more magnified.

### PLATE V.

BUCEPHALITHUS.—Fig. 1. B. Tessini.

- Fig. 2. Head of Entomostracites Buchephalus of Wallenberg, probably the female of the former.

- 3. B. Spinulosus, of medium size.

PARADOXIDES.—Fig. 4. Gibbosus. 5. Scarabæus.

### PLATE VI.

OGYGIA.—Fig. 1. O. Guettardi.

- Fig. 2. Part of the head and fore part of the body of Ogygia Desmaresti, of large dimensions, probably the male of the former.

APUS.—Fig. 3. A. Guldingi, magnified nearly three times.





Fig. 5.



Fig. 1.

Fig. 5.

Fig. 1.

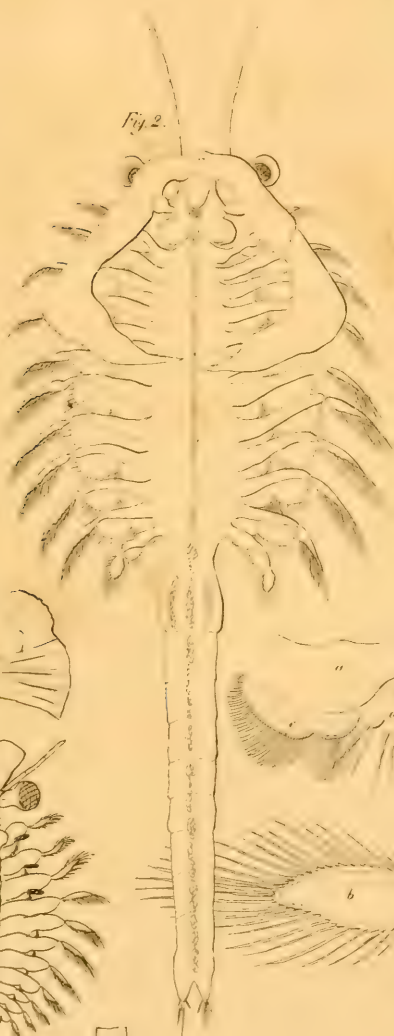


Fig. 2.



Fig. 6.

Fig. 7.

Fig. 8.



Fig. 9.

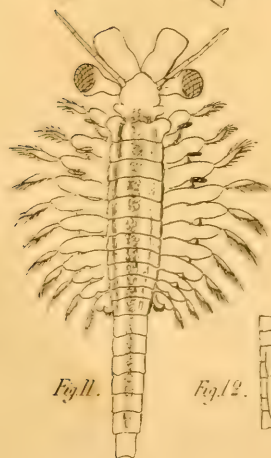
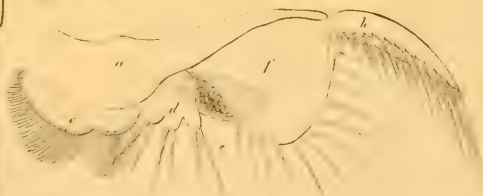


Fig. 11.

Fig. 12.

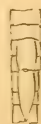
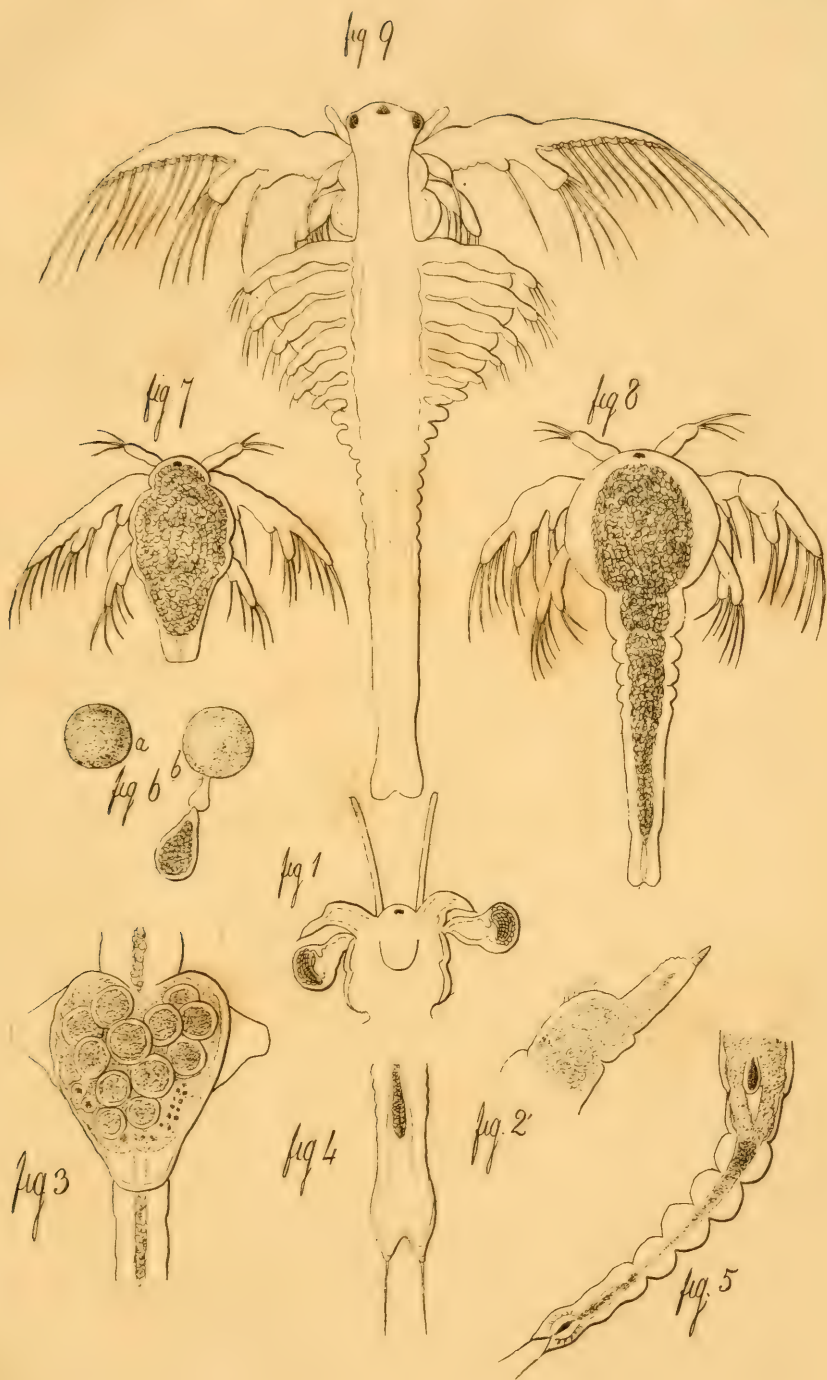


Fig. 10.







ARTEMIS.  
N. H. fecit.





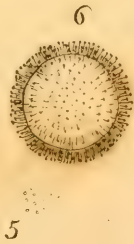
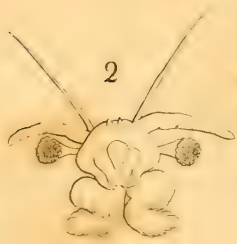
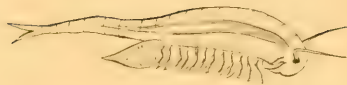
ARTEMIS &c.  
*J. V. D. fecit*





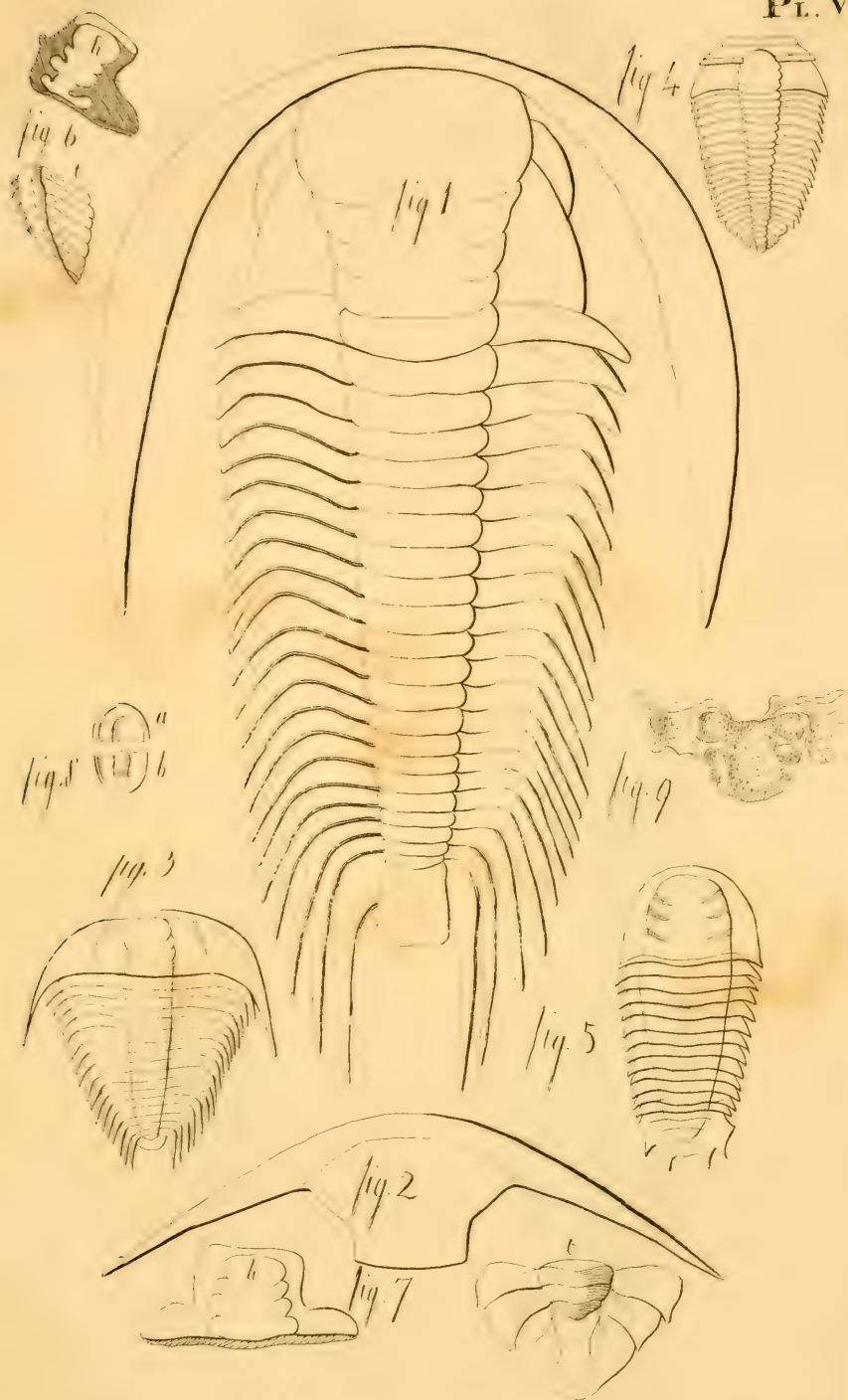
PL. IV.

fig 1



*G. L. H. fecit.*





BUCEPHALOTRITON.  
J.T.D. fecit.





fig 2



fig 3

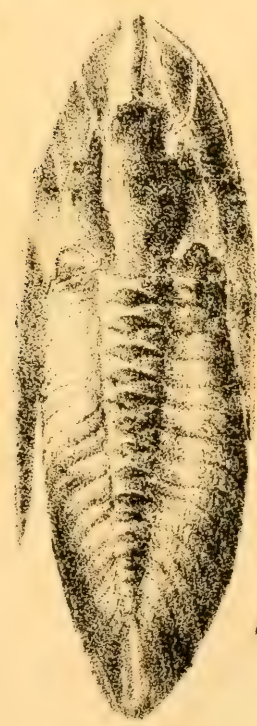


fig 1









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